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FRIDAY, NOVEMBER 16th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

ONE-HUNDRED-AND-SEVENTY-FIFTH SESSION, 1928-1929.

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 19TH, at 8 p.m. (Cantor Lecture.) FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge; "Biology and Refrigeration." (Lecture II.)

WEDNESDAY, NOVEMBER 21ST, at 8 p.m. (Ordinary meeting.) EDWARD PERCY STEBBING, M.A., F.L.S., Professor of Forestry, University of Edinburgh, "Forestry in Sweden: its Importance to and Influence on Great Britain." HIS EXCELLENCY THE SWEDISH MINISTER will preside.

INDIAN SECTION.

FRIDAY, NOVEMBER 9TH, 1928. SIR HUGH T. KEELING, C.S.I., in the Chair. A Paper on "Town Water Supply in India" was read by MR. J. W. MADELEY, M.A., M.Inst.C.E., M.Am.Soc.C.E., M.Inst.W.E. The Paper and discussion will be published in the *Journal* on November 23rd.

CANTOR LECTURE.

MONDAY, NOVEMBER 12TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the first of his course of three lectures on "Biology and Refrigeration."

The lectures will be published in the *Journal* during the Christmas recess.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

WEDNESDAY, NOVEMBER 7TH, 1928.

SIR GEORGE SUTTON, Bt., Chairman of the Council, in the Chair.

The Chairman delivered the following address:—

FIFTY YEARS OF BRITISH INDUSTRY.

During the last fifty years many important changes have taken place in the industrial world. The scale upon which enterprises are carried on has developed so rapidly that what was once regarded as a big business would to-day be considered quite a modest affair. Added to the growth in size of the individual undertaking, there has been an increasing tendency towards the amalgamation

of firms, or the establishment of groups within a particular industry for the promotion of common interests. On the other side we have had a parallel evolution of the trade union. Labour, like capital, has achieved its amalgamations and federations.

These and other changes have made business—using the word in its broadest sense—much more formidable and complex than it used to be. As my business experience extends over a period of nearly sixty years, I have witnessed many of the changes, and have taken an active part in some of them. I thought, therefore, that I could not better mark my appreciation of the honour done to me by the Royal Society of Arts in appointing me Chairman of their Council than by reviewing the changes which have taken place during my half century of practical experience.

No apology is needed for devoting an address to the subject of industry. Our industrial prosperity is the foundation of our existence and our security; it is the essential basis of those Arts with which this Society is directly concerned and has done so much to foster.

FROM PRIVATE FIRM TO PUBLIC COMPANY.

Whether the Society of Arts, which even sixty years ago was an ancient body, was concerned in the legislation which has done more than anything else to change the course of industry, I do not know. I refer to the Companies Acts. These Acts performed an essential service to industry, since without the provision of shares carrying a liability restricted to their face value, it would have been impossible to obtain the capital required for the industrial growth of the nineteenth century.

The Companies Acts, however, did much more than clear the way for the free investment of capital. They opened the door wide to the enterprise of the individual, without distinction of rank, birth or privilege. Before the Acts came into full operation the characteristic type of enterprise was the family business. It was the ambition of every man who founded a business to transmit it, strong and intact, to his sons. It might also be, but often was not, the sons' ambition to strengthen their inheritance for the next generation. The stories written around this period bear witness to the strength of such family traditions. A frequent theme of tragedy was the failure of a son to do justice to his business inheritance. Industrial interests were, in short, surrounded by the same sort of feudal atmosphere as the old landed interests.

Under such conditions it was extremely difficult for anyone not possessing advantages of birth, or wealth, or influence, to rise to a responsible position in an industrial or trading enterprise. The limits of promotion for mere ability were definitely marked. Sometimes, of course, they were overstepped; often enough men of outstanding talent and great force of character would either build up a new enterprise or secure command of an existing one. But in those days the "self-made man" was enough of an exception to carry his

half derogatory title with him all through his career. What we may call the employing or controlling caste was strongly organised and well defended.

With the development of joint stock companies, especially in connection with new industries, the aristocratic tradition was transformed into a democratic tradition. I believe that to-day every avenue of advance is open to any man possessing the requisite ability, no matter what other advantages he may or may not enjoy. That, to my mind, is at once the most striking and the most encouraging feature in modern business. It affords an assurance that the supply of competent captains of industry will never fail, because of artificial barriers in the path of promising recruits.

Democratic Industry.

For a conclusive proof of the reality of this change to a genuinely democratic system one has only to look around at the men who are in responsible control of the big producing and trading firms of the present day. A very large proportion of them are men who rose from the ranks. The same principle applies to the smaller firms and also to those managers and directors who, though not having risen to the highest command—for there is not room for everyone there—still take a leading part in developing and guiding enterprise.

Modern conditions of industrial progress are at once so flexible and so rigorous that they give an unprecedented opportunity to ability, and to ability alone. Influence may provide a man with an opening, but unless he justifies himself he can never hold the position, much less advance beyond it. On the other hand, everyone in charge of a business undertaking is conscious of an insistent demand for officers with a high degree of intelligence, initiative, and strength of character. When these qualities discover themselves in any young man, whether he be on an office stool or helping at a workshop bench, they become a certain passport to promotion.

The Desire for Wealth.

The immediate motive which urges men to seek promotion is, of course, the desire to earn wealth. Just as the purpose of a progressive business is to realise more and more profit, so the ambition of each individual engaged in it is to secure for himself a large share in the results.

The instinct of acquisitiveness is indeed both fundamental and universal. Frequently one hears it decried as a rather base passion, or at best as "mere money-making." But I see no reason for regarding the impulse to become wealthy as in itself anti-social. On the contrary, it induces men to work hard, to educate themselves, to assume greater responsibilities, to confront risks with courage, and generally to make themselves more capable and progressive members of society. In the long run, no man can augment his personal wealth without increasing the service he renders to his fellow-men. The rewards of effort may be unequal, and the majority may be destined to see

their hard work gain less than is achieved by the more skilful or fortunate minority, but every rise in the standard of living and every advance in civilisation has depended to a large extent on the strength of this primitive desire to add to one's possessions.

It would be a great mistake, however, to assume that the impulse to make money is the sole or even the dominant motive in the men who have built up or gained control of large industrial or trading concerns. The deceitfulness of riches has been a favourite theme of the moralist for centuries, and his messages would have fallen on deaf ears if they had not conveyed a truth which the wealthy were able to appreciate. Money can purchase many things—comfort, beautiful surroundings, the luxury of travel, and a thousand amenities—and it can be translated into power, prestige, and other less tangible but still desirable things. But there comes a time when the man who is growing wealthy has all that money can buy, so far as his desires lead him. This stage is sometimes reached quite early in the career of a modern captain of industry. Yet again and again we find men of this class continuing their work, reaching out into new fields, and adding one wealth-producing organisation to another. Almost invariably, by what seems to the superficial observer an inexplicable irony, they continue also to lead austere and laborious lives. Rarely do they retire to enjoy what are popularly called the fruits of their labour.

Here, obviously, we are in the presence of something more than the instinct of acquisitiveness. We touch the passion of the creative artist. I am not straining a comparison when I say that the man who conceives a project, and sets to work to realise it in factories and warehouses, in trained employees, and in all the other phases of a successful productive enterprise, operates very much as an artist does in painting a picture, and enjoys much the same triumph in achievement. There are many businesses to-day which did not exist thirty or forty years ago, save as an idea in the mind of one man. When the builder regards his handiwork—when he pictures the raw materials coming from all parts of the world to feed his machinery; when he thinks of the hundreds, perhaps thousands, of men and women who gain their living by operating that machinery or distributing the product—would it be surprising if he feels the same sort of satisfaction as a painter or a musician who has composed a masterpiece?

"Captains of Industry."

My personal observations and experience have led to the conclusion that it is this constructive faculty, and not a mere acquisitive instinct, which our industrial leaders work so hard to satisfy. Possession is not one thousandth part as interesting to them as creation. Life is for them as much of an adventure as it was to the Elizabethans who set sail upon uncharted seas, and finished one voyage only in order that they might begin another.

The conception of a captain of industry as a mere soulless piece of mechanism

stands in need of drastic revision. Success in this line of activity demands much more than driving force and the pursuit of efficiency. It needs, as I have explained, a high degree of imagination. It needs courage—courage to take big risks, often to stake everything on a single decision. It needs tenacity—the spirit which enables a man to keep his prearranged course in spite of reverses and even of failures. It needs the gift of judging the character and ability of others. It needs organising ability, in which not the least imporant factor is the gift of handling men sympathetically, gaining their enthusiastic co-operation. It needs all those faculties, so difficult to define, which we sum up in the word *personality*. They are at once so subtle and so powerful that every member of a world-wide organisation may in some degree or other reflect the personality of the man whose purposes they serve.

THE DISTRIBUTION OF WEALTH.

So far as the production of wealth is concerned, there has been a distinct improvement in the course of my life's experience, thanks to the expansion of the public company and the ample opportunities which that system of organisation gives to progressive and capable minds in every social grade. But when we turn to the distribution of wealth, we are confronted with problems which are far from being completely solved.

Behind many of the prevailing ideas about the proper distribution of wealth there lurks the feeling that wealth itself is anti-social. The contrast between a man who has millions at his command and another who barely earns his daily bread is so glaring that it leads to the belief that the duty of the wealthy man is to dissipate his millions.

I do not propose to argue this ancient question at length. It will be sufficient for my purpose if I point out that the proportion of the wealth which a rich man can possibly spend on himself is very small, and that what we call his wealth is really an organisation of machinery and men which renders a service to the community, and provides employment for a large number of people. We may rightly condemn a man who uses his personal wealth in ostentation and extravagance, but that is not a condemnation of wealth as such; it is merely a verdict on the folly of an individual. It is also a reminder that the conservation of wealth, not its dissipation, is of social value. Moreover, under the joint-stock system, the capital value of enterprises which have made fortunes for their founders is shared by thousands of other people.

The problem of the proper distribution of wealth is therefore one which concerns everybody, and not simply the few very wealthy people upon whom public attention is apt to be concentrated. Reduced to its simplest terms, it resolves itself into adjusting the reward which capital should give to labour for its service.

In the early days of industry this question was settled by a process of bargaining in which, we may admit, capital had the last word. Later, when the

workers became organised, the law of supply and demand which was supposed to govern the level of wages became modified by the power of the trade unions.

One of the most notable features of the last half-century of our industrial history has been the growth of trade unions and their organisation into federations. On the employers' side there has been a corresponding growth in the number of representative associations and in their grouping for the purpose of defending their common interests and promoting the advance of industry in general. The result is that to-day we have organised labour confronting organised capital on practically equal terms. For the first time it has become possible to deal with problems of wages and conditions of labour on national lines and to discuss the broad principles upon which agreement may be reached.

FROM WAR TO PEACE.

Still more important than this development in the machinery of conference is the change in the spirit of the men who are called upon to operate the machinery. This change is quite a recent phenomenon, but I have a confident faith that it will be more than temporary.

During the greater part of my business life negotiations with the representatives of labour had very much the character of diplomatic conversations between neighbouring States with a long history of frontier wars. Where there was not open hostility there was latent hostility. Demands made by the men, or representations made by the masters, were fought out rather than argued out, and the general tendency was to resort to the strike or the lock-out at the beginning of the discussion instead of at the end. In industry, as in other fields, the will to war was very powerful and more prevalent than the will to peace.

For a long time it seemed as if there would be no escape from this atmosphere of distrust and antagonism. The more far-seeing men on both sides recognised the destructive folly of what was virtually a form of civil war, but they found it difficult to control the rebellious forces around them. Eventually, however, a beginning was made with a more rational method of adjusting differences; and through the courage and faith of men of goodwill on both sides the seed has at last been brought to harvest.

A PIONEER INDUSTRIAL COUNCIL.

I am rather proud of the fact that the industry with which I am associated was among the first to establish a successful joint council for the discussion of all questions affecting employees. This development was greatly aided by the fact that practically all the firms engaged in the industry had themselves been organised at a very early stage. The Cable Makers' Association was founded twenty-nine years ago and was thus a pioneer in what is now called the "rationalisation" of industry. I shall deal later with its chief objects and operations; for the moment I am concerned solely with the circumstance that here, as in

very few other industries, all the employers concerned could speak and act in unison. Thus they were able not only to arrange a bargain with labour, but to guarantee its faithful execution. In place of guerilla campaigns in which individual unions fought individual firms, and frequently set one against another, there was the possibility of a general conference to arrange the terms of an enduring peace.

So we came to form our "Whitley Council." The story of our enterprise is a powerful confirmation of the proverb that "it is the first step that counts." There were indeed many first steps, in the sense that time and again the old Adam would break out at one point or another of the round table and lead to an adjournment of the proceedings.

Gradually, however, the ebullitions became less and less frequent until they practically disappeared. I attribute their disappearance to a psychological factor which, although of the simplest character, is of the most vital importance and provides the key to success in all such efforts at joint action. The peace which ensued was not the peace of exhaustion but the peace of understanding. Meeting as we did again and again at the council table, we got to know each other intimately and to realise that with all our faults and our differences of opinion we had a common denominator of decent humanity, and were alike endeavouring to do our duty by those we represented. Personal contact proved a slow but efficient solvent of distrust.

This experience is a useful reminder of the truth that machinery is less important than the spirit in which it is operated. We may devise the most perfect system of conciliation and arbitration, but it will be useless if the people concerned are not inspired by goodwill and mutual understanding. That explains in some measure why the spontaneous and more or less informal conference initiated by Lord Melchett has succeeded where official efforts have met with resistance. The personal factor has been allowed full freedom of action. Questions have been handled as man to man and not between delegates acting under rigid instructions.

THE PERSONAL TOUCH.

Personal contact is absolutely essential to a proper understanding of other people's point of view. Our repeated discussions with the representatives of trade unions gave us an insight into the ideals and difficulties of labour, while they in turn came to realise the limitations of manufacturers who had to maintain production on a profitable basis under the severest competition.

Without open and frank discussion it would have been difficult for the representatives of labour to appreciate the fact that an employer is after all a trustee for the interests of his shareholders and his customers. Without mutual knowledge it would have been difficult for the clear conviction of the common interests of employer and employed in the prosperity of their industry to emerge from the dust of perpetual conflict over wages and hours of labour.

WAGES DIFFICULTIES.

Thanks to these changes, we are now able to discuss questions of wages in the spirit of partnership. It is in that spirit I wish to offer a few observations on one or two outstanding difficulties.

The prevailing rates of wages are fixed partly by custom and partly by arrangements made with the trade unions concerned. Trade union policy aims at uniformity; it is satisfied if the standard rate of wages is accepted by all employers and paid to all workmen, irrespective of the personal merit of the worker or the prosperity or otherwise of any particular factory or group of factories. The object of this policy is the meritorious one of securing to every worker a living wage and if possible something more. Yet it must be admitted that the standard wage system imposes an artificial uniformity in a field where there is a great natural diversity.

From the point of view of the individual worker, it means that no matter how skilful he may be or how hard he may work, he cannot advance beyond the standard rate of wages.

From the point of view of the individual factory or industry, it means that no matter how hard-pressed it may be, it cannot meet the situation by reducing wages, and no matter how prosperous it may be, it cannot pay more than the standard rate.

Let me give an illustration. Many different industries—engineering shops of various kinds, shipyards, and my industry of cable making—employ the highly-skilled men known as fitters. Shipbuilding and some branches of engineering are, for reasons largely outside their control, in a depressed state. On the other hand, cable-making, on account of the ever-increasing development of electricity, is prosperous. Within that industry itself there are degrees of prosperity. If the level of wages were regulated by the prosperity of each separate undertaking, the workers in the less prosperous concerns might feel a sense of injustice which would introduce a distinct element of discord.

ANOMALIES IN WAGES.

There are other anomalies which the joint councils of our various industries would do well to attack. One is the disparity of wages in sheltered and unsheltered trades. Is it right that skilled workers should be paid no more, and sometimes less, than workers in unskilled trades? This anomaly has arisen simply because the sheltered trades have been able to raise the cost of their service to the public and consequently pay their employees more than the natural relative value of their work. While it endures, it has a tendency to attract into lower-grade occupations men who would be capable of giving better service and employing their faculties more fully and more happily in skilled work.

The ultimate object of trade union activity is to secure to labour a larger share in the results of industry. To-day, much more than in earlier times, it is

realised by the representatives of Labour that this is a very complicated problem not capable of complete solution merely by incessant action to force up the general level of wages.

PIECEWORK.

When this problem is considered, most people's thoughts turn to piecework and profit-sharing. Piecework, however, is applicable only to certain types of labour and it is not regarded with much favour by the trade unions. Their objection to it is partly a general dislike of all departures from standard rates of pay and partly a distrust born of experience. Cases have occurred where piecework terms have been modified by the employer because a proportion of workers have regularly earned more than was considered appropriate to the grade of labour. Where such modifications have been enforced they have engendered a very unfortunate—and I think quite natural—sense of hostility and distrust, but we may hope that in the better spirit of mutual confidence which prevails to-day it will become possible to extend the piecework system on a basis satisfactory to both parties.

PROFIT SHARING.

In some quarters profit-sharing is regarded as a complete solution of the problem. Opinion is, however, still divided as to its merits, or rather the extent to which it can be usefully applied. The underlying principle is sound enough, as it gives the workers a share in any advance beyond a standard measure of prosperity. Where an industry is of a comparatively steady character, as in the case of a public utility or of a company supplying a commodity in regular demand, it affords a convenient method of securing a periodical bonus to the staff. But difficulties arise when fluctuations occur from profit to loss, and as a general rule the workers are more attracted by the prospect of a higher weekly wage than of lump sums at widely-separated periods.

So far as manufacturing industries are concerned it is, I think, better to aim at a system which secures to each grade of worker the highest possible wage, rather than to attempt to apply a rigid profit-sharing system to a constantly changing set of conditions. There are, I admit, cases where profit-sharing has been successfully applied and is firmly established. On the other hand, there are cases where it has not proved popular. The inference which may fairly be drawn, is that a very careful survey of each case should be made before the hope is entertained of making all grades of workers contented by means of profit-sharing.

CO-PARTNERSHIP.

Co-partnership is a somewhat different proposition, as it aims at enabling the workers gradually to acquire a proprietary interest in the concern from which they draw wages.

Here again it is difficult to discover a solution applicable to the general run of industrial concerns. The only type of company in which a worker should be encouraged to invest his savings is one of a steadily prosperous character. These are precisely the cases where the price of the shares advances far beyond the nominal value and gives the purchaser a yield not much greater than on a gilt-edged stock. If, therefore, the worker buys the shares at the market price he secures only a modest return; and if, on the other hand, the company allows its employees to acquire shares at par, it must consider that it is presenting them with a substantial bonus at the expense of the other shareholders.

The difficulty which is here indicated is not confined to problems of co-partnership. It affects the development of industrial enterprise in general. When a company has become fairly prosperous, the rise in its share level gives the original shareholders an opportunity, which they generally seize sooner or later, of realising at a substantial profit. The new shareholders buy their shares at such a price that unless the Company maintains its dividend the yield becomes unsatisfactory. Thus we reach the curious state of affairs in which a Company struggles hard to keep up a 15 or 20 per cent. dividend on its ordinary shares while the general body of shareholders actually realise nothing more than 5 or 6 per cent.

The Reward of Labour

Returning to the broad question of the distribution of wealth, there is an important point upon which a great deal of controversy has turned.

We hear it argued by idealists that the reward of labour should come before that of the employer. However attractive this may be in theory, it can hardly be said to provide a sound working principle. The mainspring of enterprise is the desire to earn a profit, but if the claims of labour are to take precedence of this primary factor it is inevitable that enterprise will be discouraged. Labour will gain much more in the long run by encouraging initiative than by imposing upon all industrial adventures the duty of meeting, before all else, whatever claims the rank and file may choose to make upon those who are risking their money and their professional reputation.

Similarly in the case of an established undertaking. The capacity to earn a profit is the fundamental condition both of survival and of progress. Everything must be made subservient to the need of reaching the profit-earning stage. As the recent remarkable agreement between the railway companies and the railwaymen's unions clearly shows, the truth of this contention has come home to the workers. They have agreed to an all-round reduction of 2½ per cent. in wages because they realise the necessity of restoring the railways to the profit-earning level. Without that restoration, their hopes of regular and well-paid employment must gradually disappear.

The more this matter of profit-earning is considered, the more definite

becomes the conviction that labour has everything to gain and nothing to lose by encouraging the making of substantial profits. In most industrial undertakings employing large bodies of labour, the workers would stand to gain nothing appreciable if dividends were distributed among the employees instead of the shareholders. Interest on capital is usually a very small fraction of the total wages bill. But when dividends are substantial, the workers stand to gain in various directions. Steady, well-paid work is assured them; the company enjoys the security and resources which enable it to extend its salesmanship and obtain new orders; and the dividends make it easy to secure capital for extensions, for renovations, for replacement of old with more efficient plant, for research, and for other developments which improve and widen the market for labour.

In short, profit for the shareholder means progress and prosperity for all concerned—labour not least of all. Viewed in this light, the once prevalent notion that profit was something taken from the worker and given to the people who had no just claim upon it, is seen to be false. From the ambition which human nature entertains—selfishly if you like—comes enterprise, and from enterprise conducted on a profitable basis comes the ability of a community to maintain an increasing population in comfort and amenity.

The Social Value of Profit.

It is necessary to emphasise the social value of profit because the contrary view is likely to hamper an industrial development of a most important and useful character.

I have already referred to the tendency of firms engaged in the same industry to unite for mutual benefit. This is a comparatively recent phase of industrial evolution. Fifty years ago the individualist principle was supreme. Every firm prided itself upon its independence and accepted the law of unfettered competition as not only a natural but an absolutely beneficial dispensation. Public opinion was dead against any measures whatsoever for modifying the rigour of rivalry, whether at home or abroad.

A different spirit prevails to-day, and its growth is one of the most significant of the changes I have witnessed.

The causes of the change are not obscure. An industrial policy of laissez-faire was appropriate enough when Britain enjoyed a practical monopoly in most fields of engineering and kindred enterprise. The world was ours, and it was so wide that individual firms found plenty of elbow room for the exploitation of an ever-increasing demand. But when the Continent and the United States of America began to build up productive organisations of their own, British firms found one market after another being closed to them. They also found themselves competing, not with individual firms, but with industries organised within themselves and in conjunction with banks and even with Governments, so that a formidable combination of State influence, powerful finance houses, and

co-operating producers was encountered in overseas markets and even in our own home market.

Some time elapsed before the alteration in the conditions was fully realised and steps taken to meet it. The traditions of independence are slow in dying, and it was difficult for firms which had always pursued their own course and treated competitors as their natural enemies to reconcile themselves to the limitations and sacrifices involved in common action. Even to-day there are many industrial groups where the members chafe under the chains of co-operation, and threaten at frequent intervals to break them. The only thing that restrains them is a recollection of their much less fortunate condition when anarchy prevailed.

THE STORY OF THE C.M.A.

I have already mentioned that the Cable Makers' Association was one of the first bodies of its kind to be formed. It will be interesting, I think, to review its history in order to indicate the reasons for the formation of the Association and to outline its activities and its results.

Fifty years ago the electric lamp was born, and in turn gave birth to a new industry—the generation and distribution of electricity to the public. Previous to that event, the telegraph, both land and submarine, was the main item in electrical engineering, and when the demand arose for insulated cables suitable for electric lighting, it was natural that the firms engaged on telegraph cable production should endeavour to meet it.

Many new problems, some chemical, some physical, some electrical, some manufacturing, had to be solved. The carrying of heavy currents at high pressures was in many respects a more formidable problem than that of transmitting the light currents used in telegraphy. The public safety was involved in the solution of these problems; so also was the prosperity of the new industry, since reliability, efficiency, and long life in cables were essential to satisfactory service.

At an early stage in the cable-making industry, the firms became acutely conscious of these problems and also of the opposition between the need for a high standard of quality and the desire for cheapness. They also realised that there was nothing to distinguish, in the sight of the ordinary buyer, a high-grade cable from a low-grade one. There was an obvious danger that unregulated competition would make price the sole consideration in cable contracts and would thus bring about a steady deterioration in the quality of the all-important link between the power station and the public, and of the wires which the user of electric light installed on his premises.

In order to avert this danger the leading firms came together twenty-nine years ago and formed an Association primarily for the purpose of fixing and adopting standards of dimensions and quality in electric cables. To-day these standards are recognised all over the world. It is largely to them that we owe

the exceptional reliability of electric supply in this country and the high degree of safety which attends the use of electricity in our homes and in buildings of all kinds. It is perhaps worth recalling that during the War many of our networks of electric mains were heavily overloaded owing to the successive additions of munition factories. The strain put upon them for months, and in some cases years, was far greater than anything regarded as possible, to say nothing of permissible, when they were designed and manufactured. Nevertheless; the margin of safety provided by high quality insulation, and ample dimensions, enabled them to carry their tremendous overloads with only an occasional interruption.

REGULATING COMPETITION.

The co-operative action of the Cable Makers' Association did not, however, end with standardisation. It extended to the field of competition.

At that time it was a very rare and a very suspect thing for firms in the same line of business to agree not to engage in an orgy of cutting prices or not to work ruthlessly towards the extinction of competitors. The Cable Makers' Association proceeded on the assumption that the field was large enough for the growing prosperity of all of them and that their individual as well as their common interests and those of electrical enterprise as a whole would be best served by keeping competition within reasonable bounds.

This view was not, as you can well imagine, shared spontaneously by the public or by the buyers of cables. The Association was regarded as a "ring" and incontinently denounced as such. Protests were continually being made against the maintenance of prices, and in some quarters the break-up of the Association would have been welcomed as an unmixed boon.

Many attempts were made to achieve this destruction. They were made by firms in this country; they were made, on a much more formidable scale, by firms abroad. But the Association was able to resist all these attacks, and its survival is a conclusive proof that the members were able to render better service than their opponents. Users of cable might denounce "rings" in more or less emphatic language, but they appreciated the vital importance of quality in cables and they realised the value of the guarantees which the Association was able to give with the full weight of organised firms of the highest repute.

Moreover, the security which combined action gave to the firms concerned enabled them to keep abreast of, and indeed ahead of, the needs of a rapidly expanding and changing industry. As the electric light undertakings developed into power supply undertakings, new technical and manufacturing problems arose, demanding for their solution a great deal of costly research and experiment. It would have been impossible for the industry to undertake this development work if it had not enjoyed the security and the financial resources which a measure of combination afforded. As things were, it was able to increase its output continually and to keep always in the vanguard of technical

progress and manufacturing efficiency by a judicious use of the strength which organised prosperity gave to it.

The C.M.A. rightly claims that it has "demonstrated that it is possible for a number of firms, entirely independent of one another financially, and, broadly speaking, working competitively, to concentrate the competition on being one of quality and effective service to the customer, rather than on to a ruinous price competition. The effect of the economies arising from concerted action in the directions which have been indicated has been such that the actual prices are so low relatively to the quality dealt in, that it has been almost impossible for newcomers to the industry to offer equally high qualities at lower prices."

One need not be surprised therefore, that the Cable Makers' Association has been adopted as a model for later groups of manufacturers and has done a great deal to allay the public suspicion with which every form of industrial combination was once regarded.

THE VALUE OF AMALGAMATION.

The principle of industrial combination is now as firmly established as the principle of amalgamation which came into force about the same period. It may be said that it is more firmly established, since the advantages of combination increase with every application of the principle, while in the case of amalgamation there are strict limits to the benefits which can be realised.

The object of amalgamation is to secure greater economy in production, management and salesmanship, greater financial stability, and a firmer hold over raw materials and the conditions of sale for the final products. Where firms are engaged on precisely the same form of production, or where they contribute their several manufactures to cover a particular industry— such as electrical engineering, or chemicals—amalgamation will secure its object if judiciously carried out on sound financial lines.

There have been, however, cases of amalgamation where firms have absorbed others with which they had no organic relation. The result has been that a medley of problems of production and salesmanship had to be solved by a board without cohesion, without the capacity or the opportunity to frame a common policy. Amalgamations of this kind are simply an overcapitalised anarchy, and their inevitable future is a drastic process of restoring the several parts to independent ownership and writing down the capital to something approaching the true value of the assets.

War conditions encouraged a great deal of this reckless union of incompatibles. Amalgamation was held to be a prime element in the reconstruction which was needed to prepare British industry for the after-war of international commerce; and in the rather fevered temper of the times the limitations of even an uncontroverted policy were not always recognised. We understand better to-day that an amalgamation may be weaker than its component parts, and that great

skill in selection is needed to secure the genuine unity which alone means strength.

Peace in Industry.

We now live in an era of Big Business. The tendency of the time is to concentrate the power of control over production by mergers or amalgamations in one form or another. At the same time, where manufacturers remain independent, there is a complementary movement towards unity by the formation of industrial and trade associations.

Both movements will, I am sure, tend to greater prosperity for everybody engaged in industry and to better service to the community. They will also, as I have already indicated, smooth the path of industrial peace by enabling decisions about the conditions of labour to be reached by a small but fully representative conference and given effect over the greater part of the industrial field.

While on this point I would like to suggest an effect which the higher organisation of industry will have upon the cause of industrial peace. So far as our own country is concerned, efforts are being made to modify competition by co-operation, and it appears that steps have been taken in some industries to make treaties with the organised industries of other countries. If this movement continues, the nations will in time be bound together by a series of *industrial agreements in which their interests are closely involved. This network should prove a powerful reinforcement for the foundations of international peace.*

Research.

The better organisation of industry, both by amalgamation and the formation of associations, has a direct bearing upon the important subject of Research. It used to be a common subject of reproach against our manufacturers that they neglected research. A generation ago there may have been plenty of ground for the reproach; to-day it is only in exceptional cases that it can be justly applied. And the change is largely due to the transformation from independent competing firms to co-operating organisations.

Industrial research on the modern scale is a very costly and speculative undertaking. It needs large laboratories, equipped with expensive plant and manned by highly skilled experts in various branches of science. Its purpose is to adventure across the frontier between knowledge and ignorance and reach out over the unknown in the hope of discovering a treasure. However skilfully conducted, missions of this sort may only too readily end in nothing.

Clearly no industrial firm can embark on an organised research policy without possessing security, stability and surplus profits. When our industrial picture revealed a number of small and exclusive companies fighting each other gallantly for every order that came along, cutting prices in a desperate effort to maintain

output in the face of both home and foreign competition, and experiencing rapid fluctuations of good and bad fortune, there was no place where research could have been introduced. The utmost that could be attempted was the equipment of a works laboratory for the testing of materials and for occasional experiments on new inventions. To spend thousands of pounds on a research department and install in it a physicist, a chemist, a metallurgist and other specialists in the hope that they might eventually achieve some beneficent revolution, was altogether Utopian.

With the growth of organisation, however, the whole situation changes. A large amalgamation or an industrial association can afford to face the cost and accept the chances of research on elaborate lines. The research laboratories to which our attention is so often drawn on the Continent and in the United States are all associated with the largest and most prosperous Trusts. The further we carry our industrial organisation either by amalgamation or combination, the more capable we shall become of bearing the luxury—a very profitable one at times—of reasearch.

Let me again draw an example from my own experience. Some years ago the cable-making industry realised that it enjoyed a rather imperfect knowledge of what actually happened to its cables when laid underground. Dimensions and materials had been determined on empirical lines and they were known to be satisfactory in a general way. But no one knew with scientific precision whether the standard sizes of cable were capable of rendering a higher service than that for which they were specified.

The problem was one which concerned every cablemaker; or rather, it concerned the user of cables more than the manufacturer. A committee was appointed by the Electrical Research Association to investigate the subject of the heating of buried cables, and through the existence of the organisation of the leading cable makers, this joint experience was available for the use of the committee, and the result of this co-operation was that the Electric Supply Authorities were assured that they could effect material economies in their transmission systems.

A further development of joint research is now under way. Each member of the Cable Makers' Association has been engaged upon independent research for a number of years. Their enterprise in this direction is part of the healthy rivalry which is maintained within the circle of the Association. But it is inevitable that several of the cable research laboratories must be engaged simultaneously upon the same problem—as, for example, the behaviour of insulating materials at the extra high pressures now adopted on mains transmitting large quantities of electricity over long distances. Duplication of this kind tends to waste of effort, and arrangements have recently been made for co-ordinating the material and mental resources of many cable research laboratories on the main problems awaiting solution.

In enterprise of this description the British manufacturer finds invaluable aid

in the National Physical Laboratory and the Department of Scientific and Industrial Research. Of late years the State has, through these organisations, so efficiently seconded the research work of large industrial firms and associations that we may rest assured that the help which science can render to industry is being adequately exploited.

EDUCATION.

Now I come to an aspect of my subject upon which, though it is of great importance, I can do no more than briefly touch. I refer to education, in connection with which this Society has played a most distinguished and useful part.

The fact that the Royal Society of Arts has held this year, examinations, for which there were over 100,000 entries, is proof of a wide-spread desire for education among recruits in the army of commerce. All these candidates desire to excel in some special branch of knowledge. This desire is the only thing that really counts. I feel it would be a waste of public fund to try to force young people to acquire knowledge and proficiency if they have no genuine desire for the acquisition. Attempts in that direction have been made in recent years, but they have failed in their purpose. Young people should certainly be encouraged and helped to make themselves more proficient for the battle of life, but a voluntary impulse on their part is essential to success.

If we are to make the best of the material which the school provides for the manning of our industrial army, we must enlarge the opportunities for education until they are open to all. The ideal educational system is one which provides a clear course from the elementary school through the secondary school to the University, for those who have the character to avail themselves of it. Educational progress is already tending in this direction, and I think the advance would be accelerated by the provision of scholarships by the State. Some assistance of this kind is essential if equal chances are to be enjoyed by all grades.

Of late years there has been an increasing desire to employ public school boys in industry. Their training fits them admirably in many ways for positions of control, but they labour under the disability that they enter the workshops or offices at a comparatively late age. The lad who goes direct from the ordinary school into employment has gained five or six years practical experience, and has therefore become definitely useful to the employer, by the time the public school boy comes on the scene.

What the employer wants is, of course, a combination of higher education and practical experience. Under present conditions this combination is generally impracticable and a choice must be made of one or the other. Whether it is possible, by some revision of our system of training, to secure a measure of both qualities in the young men who are fitting themselves for responsible positions, is a problem which our educational authorities should seriously consider.

In this connection I do not overlook the excellent results which have been achieved in technical training when a really great teacher gets around him a body of students attracted by the tradition of his teaching. I have in mind two outstanding examples in the Electrical world, one the old Finsbury Technical College under Professor Ayrton, and the other the Faraday Training Institution under Professor Harrison and Dr. Alexander Russell.

In this review of a half century of industry I have touched upon some of the principal changes and dealt with important problems which have been solved or still await solution. Surveying this period of our industrial history as a whole, I think it reveals a great deal of solid and enduring achievement and encourages the confident belief that, if we make intelligent use of our resources, and above all of our human resources, the future will witness a continuous advance in the general welfare.

THE CHAIRMAN then presented the Society's silver medals for Papers and Lectures delivered during the last session as follows:—

Papers read at the Ordinary Meetings.—

S. J. Duly, M.A., Head of Department of Commercial Products, City of London College, Mitchell Student for 1925-6, "The Damage to Cargo due to 'Ship's Sweat.'"

Major R. G. H. Clement, M.C., M.Inst.C.E., "The Evolution of Modern Road Surfaces."

Charles Herbert Wright, B.A., "Modern Aspects of Rubber Cultivation."

Alfred C. Bossom, F.R.I.B.A., "American Architecture."

William Taylor (of Messrs. Taylor, Taylor and Hobson, Ltd.), "Standardisation in Apparatus for Science Teaching."

Captain Reginald Willington Lane, "The Sterilisation of Milk."

Papers read before the Indian Section.

Mr. M. S. Gubbay, C.S.I., C.I.E., "Indigenous Indian Banking."

Sir David T. Chadwick, C.S.I., C.I.E., "The Indian Tariff Board."

Sir C. Stuart Williams, M.A., Chairman of the Commissioners of the Port of Calcutta, "The Port of Calcutta and its Post War Development."

Papers read before the Dominions and Colonies Section.

His Excellency the Marquis de Merry del Val, G.C.V.O., LL.D., Spanish Ambassador, "The Djebala and Riff Country of Morocco" (with cinematograph illustrations).

Sir Stephen Montagu Burrows, C.I.E., "The Ancient Civilisation of Ceylon."

Trueman Wood Lecture.

Sir James H. Jeans, M.A., D.Sc., LL.D., F.R.S., "The Wider Aspects of Cosmogony."

Sir George Birdwood Memorial Lecture.

Sir Edward A. Gait, K.C.S.I., C.I.E., "Ancient Bihar and Orissa."

MR. ALAN A. CAMPBELL SWINTON, F.R.S., in proposing a hearty vote of thanks to Sir George Sutton, said that all present would agree that the address which they had just heard from Sir George Sutton was of a very remarkable character. It had been his (the speaker's) good fortune to have had personal relations with a number of Captains of Industry. He had begun in the year 1881 by being apprenticed to the first Lord Armstrong, who had undoubtedly been a great Captain of Industry. Later he had come under the aegis of Sir Andrew Noble, who had followed Lord Armstrong in the business of Messrs. Armstrong, Whitworth until his death. He was also personally acquainted with another Captain of Industry, Sir Charles Parsons. Nevertheless, he thought that he could say truthfully that not one of those gentlemen could have given as good a lecture upon Industry as Sir George Sutton had delivered that evening.

As a rule the qualities which made a man successful in business were not the same as those which made him a good writer or speaker. Certainly his own experience was that some of those with whom he had had to do, who undoubtedly were very great men in the industrial world, were the worst speakers he had ever come across; but those present that evening had had a really remarkable exposition of a very complicated subject, which showed that Sir George Sutton had given a great deal of thought, not only to the work to which he had devoted his life which was the Cable Industry--but to Industry in general, and that he had a very comprehensive grasp of the whole subject--a more comprehensive grasp than most people, certainly politicians, possessed. He thought that the Royal Society of Arts was very fortunate in having for its Chairman a gentleman who had such wide experience and knowledge, and who was able to impart it in such a very interesting way.

SIR EDWARD GAIT, K.C.S.I., C.I.E., in seconding the vote of thanks, said he was sure that everyone present could not but feel the highest admiration for the thoughtful, comprehensive and most illuminating address which Sir George Sutton had given.

The vote of thanks was carried unanimously.

THE CHAIRMAN, in acknowledging the vote, said he had been afraid that his address might be boring to his audience, but there had been nothing else upon which he could have addressed them. He believed his position on the Council of the Royal Society of Arts was due to his contact with the commercial life of this country. There were all sorts of very eminent people on the Council, and he confessed that he had felt a little frightened to come before them and give an address upon commerce. However, he had got through it, and he thanked the audience for the patience with which they had listened to him.

NOTES ON BOOKS.

A SHORT HISTORY OF MEDICINE; INTRODUCING MEDICAL PRINCIPLES TO STUDENTS AND NON-MEDICAL READERS. By Charles Singer. Oxford: at the Clarendon Press. 7*s.* 6*d.* net.

Dr. Charles Singer, who is of Oxford as regards primary standing or graduation, now does good service in the University of London as "Lecturer on the History of Medicine." The author's "Studies in the History and Methods of Science," a gathering from many sources, with himself as editor and unifying factor, has led

him to his recent booklet on Greek Biology and Greek Medicine; also to the work under notice.

Thoroughness and accuracy are combined with that lucidity which results from an orderly habit of thought, and care in the selection of words, hence the book is well suited for the popular library and ordinary reader, but the veteran medical practitioner may be just the one to find full joy in adding it to his library. Its total of pages is XXIV + 368, and abundant illustration is a feature -143 illustrations all told, many being whole-page reproductions. All illustrations are so strictly germane to the text as to strike the reader at once in a first general view of the work, and often exemplify Dr. Singer's characteristic manner of blending ancient with modern history. Opposite p. 46 we have a whole-page reproduction showing the ruins of an ancient Roman aqueduct. This illustrates the account of Roman sanitarians, as strengthened by that Julian edict which "conferred citizenship on all who practised medicine at Rome, in order to induce physicians to settle" (p. 46). Vitruvius, who was technical adviser to Julius Cæsar, treats at length of water supply in Book VIII of his *De Architecturâ*, and he upholds the open aqueducts as against transmission by pipes, especially leaden pipes. The Roman military dressing-station (from Trajan's column) shown by Fig. 17, contrasts with Fig. 128, in which Florence Nightingale is shown as receiving wounded at Scutari; a similar contrast being found by comparing Fig. 112, an operation in the sixteenth century, with Fig. 113, where we see work under those antiseptic conditions embodied in the general term Listerism. The growth of antiseptic surgery runs through the book; Figs. 106 and 107 leading the mind to the conclusive theoretical position established by Pasteur. Abundant illustrations are given of microbial organisms as bearing on practical Listerism, and on the various infective disorders, largely or mostly febrile, now known to be of microbial origin.

Fig. 110, on p. 203, is in no sense pictorial; it being a chart or graph showing the notable and almost unbroken diminution in mortality by laryngeal diphtheria during a period of seventeen years, the test area being one in which antitoxin serum was used. In the section (headed "The Study of Immunity"), including the above-mentioned chart or graph, we find an account of the ways in which dead products of microbial action can give protection, either partial or complete. So widespread is the use of such toxins or serums that one may now have a puppy inoculated against distemper.

Mechanical appliances as used by the practitioners of old times are figured in many places, but we may mention the "bob," or "momentum," drill figured on p. 64, and shown in use by the seventh-century reproduction, Fig. 22 on p. 63; also we turn to Fig. 9, which shows us a sixteenth century trephine made in accordance with descriptions or inspirations from ancient Greek sources, and to Fig. 15, where a group of first-century surgical instruments, found at Pompeii, is delineated. The special interest of these relics of Rome is that they are actual possessions, showing not only the design but the workmanship, the mechanical dilator with screw adjustment and two-part speculum being of very notable interest.

The final illustration, "Friendly Death," is opposite p. 362, and bears on Dr. Singer's epilogue; the picture shows us a belfry in which the conventional figure of Death is tolling the passing bell, but with head slightly bowed and face turned away from the open eastern arch, through which the first gleams of dawn are shining. These morning gleams faintly illuminate the face of the old man, who is almost smilingly passing through the *Janua Vitae*, and in the text opposite we read the author's teaching as to the true function of medical science. This must be read to be understood, but a note running through the whole is that the intelligent practice of medicine "should enable us all to live out our full lives."

Although, in the main, a record of triumphant progress and joy, a faint strain of threnody may be traced in many parts of the Epilogue, pp. 352-362. Dr. Singer tells us of the "unreadable bulk" of scientific literature (p.353), and deals with the growth of modern Determinism; then he goes back three centuries to Descartes, against whose oft-quoted basic doctrine a "newer school" is showing itself; a school that seems to attack or deny mentalism and to exalt materialism, p. 356. Here the author feels himself in the presence of a dilemma, which he cannot cast off at the moment; but he goes so far as to say that "determinist thought, which lies at the basis of modern medical developments, has not been so universally successful as is often supposed." The tendency has been to separate those strains of knowledge (end of p. 353; also of p. 356) which give the full aspect of things when taken together. As an outcome we have the view that "the Humanities and the Sciences are far from being as independent of each other as many suppose"; that "the growing interest in science has had an unfavourable effect on education," and that "many scientific publications are but semi-literate."

Here, indeed, is a book which all classes may read with advantage, and the epilogue should be specially studied by our administrative and educational officials.

THE CHEMISTRY OF CRUDE DRUGS. By John Edmund Driver, M.Sc., Ph.D., A.I.C., Lecturer in Chemistry, University College, Nottingham; and George Edward Trease, Ph.C., Lecturer in Pharmacognosy, University College, Nottingham. London: Longmans, Green & Co., Ltd. 10s. 6*d*. net

The term "crude drugs" is generally used to denote simple tinctures, extracts, etc., derived directly from such natural products as roots, leaves and seeds. In this form the preparations necessarily consist of mixtures of a number of substances; but for many purposes pure compounds are not needed, and these mixtures therefore find a very wide application in pharmacy.

While the more important examples are familiar enough, in respect of name, origin and physiological properties, to pharmaceutical students, the authors have rightly considered that there exists an unnecessary hiatus between the teaching of materia medica and that of organic chemistry. The function of the present text-book is to bridge this gap, and it may be said to do so in an admirable manner; in fact it should prove not merely useful to the pharmacist, but also extremely interesting to the student of organic chemistry, who is accustomed to finding a certain dullness in pharmaceutical works.

The classification and treatment throughout are chemical instead of morphological, and structural formulæ are usually given. It may perhaps be open to doubt whether the average pharmaceutical student will take a very intelligent interest in the structural formulæ of even such a comparatively simple molecule as that of (say) borneol, if he is ignorant of the long history of the determination of that structure; but even he will obtain considerably more benefit from the full picture than from such a representation as $C_{10}H_{18}O$.

An excellent feature of the book is the compilation of classified tables collecting together much useful information as to the origin of groups of drugs, and also as to their principal constituents. It has been the policy of the authors to avoid over-burdening the book with references to original papers, but much recent work has nevertheless been incorporated, as may be seen by referring to such subjects as the constitution of muskone, or the characteristics and determination of the vitamins.

COMMERCIAL ART PRACTICE. By Charles Knights and F. E. Norman. London: Crosby Lockwood and Son. 15*s*.

The posters of Mr. McKnight Kauffer have proved that the words "Commercial Art" are not necessarily contradictory. Before they had done so, Mr. Roger

Fry had written that perhaps advertising might evoke originality in someone. Of ingenuity, at any rate, it has been most productive, and though we are less attracted than distracted by contemporary hoardings we must admit that here and there interesting work is to be seen.

In the United States there are, I am told, some six hundred thousand folk connected with advertising. The number in the United Kingdom must also be impressive. Commercial artists abound; the young man or woman who intends to enter the field and compete with them will find many useful hints in this book by Messrs. Knights and Norman.

They have a certain amount to say about psychology. What, as a matter of fact, is the last word about the reactions of the public to the counter-claims of the poster? What is the megalomaniac to do who is informed that the "Majestic" is the largest vessel afloat, whereas the "Leviathan" is the biggest steamer in the world? One understands that the soap-merchant who can afford to advertise sells more soap than the one who cannot; but if there are two equally fast and efficient trains to John-o'-Groats, and we have no alternative but to go by one of them, what is the point of either of them being boosted?

The practical side of "Commercial Art Practice" is excellent. The authors explain the various reproductive processes most thoroughly, and illustrate them in such a way that no one could fail to understand them. Blocks, tints, type faces are all dealt with; then there are chapters about design and layout; finally the domestic economy of free-lancing receives attention. I wonder whether the authors chose the type in which they have here been printed. The ligature does not quite seem in keeping with such a robust subject.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 19. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Sir Arthur J. Evans, "The Palace of Knossos in the Light of Recent Reconstitutions."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr A. P. Laurie, "Chemistry: Modern Pigments: their Proper Selection and Use."

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Schweich Lecture I.)

Electrical Engineers, Institution of, at the University of Liverpool. 7 p.m. Prof. G. F. Scholes, "Combustion."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Miss G. Caton-Thompson and Miss E. W. Gardner, "Recent Work on the Problem of Lake Moeris."

Imperial Institute (Cinema Theatre), South Kensington, S.W. 10.15 a.m., 11.35 a.m., 2.15 p.m. and 3.35 p.m. "India."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. G. R. Bamber, "Automatic Combustion Control of Furnaces."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (1829-1928)." (Lecture II.)

At the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Mr. Ifor L. Evans, "Economic Problems of the Danubian Area."

At King's College, Strand, W.C. 5.30 p.m. Rev. Dr. R. S. Franks, "Protestant Scholasticism."

At the London School of Economics, Houghton Street W.C. 5 p.m. Don S. de Madariaga, "Disarmament." (Lecture III.)

At University College, Gower Street, W.C. 5 p.m. Professor E. B. Verney, "Urinary Secretion." (Lecture VI.)

5.30 p.m. Dr. Paul Stamberger, "Colloid Chemistry and its Relation to the Rubber Industry." (Lecture IV.)

TUESDAY, NOVEMBER 20. Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. A. Leslie Armstrong, "Report on Excavations in the Tin Hole Cave, Cresswell, and the recent Discovery of an Engraving of a Masked Human Figure."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Chemistry—Methods of Wall Painting."

Automobile Engineers, Institution of, at the Engineering Club, Wolverhampton. 7.30 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Prof. W. E. Dalby, "Mechanical Properties of British Rail-Steels."

Heating and Ventilating Engineers, at Milton Hall, Manchester. 7 p.m. Mr. W. Gregg, "Fabric Drying."

Imperial Institute (Cinema Theatre), South Kensington, S.W. 10.15 a.m., 11.35 a.m., 2.15 p.m., 3.35 p.m. "India."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 7.30 p.m. Mme. G. M. Vassal, "Through Tonking and Yunnan."

Royal Institution of, 21, Albemarle St., W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture I.)

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Mr. A. W. Flux, Presidential Address, "The National Income."

University of London, at King's College, Strand, W.C. 5.30 p.m. Miss Hilda D. Oakeley, "Aristotle's Idea of Deity."

5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VII.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. H. Clifford Smith, "The Furniture and Equipment of the Home."

6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture II.)

At Westfield College, Hampstead, N.W. 5.15 p.m.

Sir Charles Grant Robertson, "The Map of Europe." (Lecture II.)

WEDNESDAY, NOVEMBER 21..Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Chemistry—Recent Researches on the Preservation of Ancient Buildings and Stone Decay."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testament in Muslim Religious Art." (Schweich Lecture II.)

Chadwick Public Lecture, at 11, Chandos Street, Cavendish Square, W. 5.15 p.m. Dr. E. P. Cumberbatch, "Physio-Therapy, with special reference to Medical Electricity."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Address by Mr. H. G. Cousins (Chairman of Students' Committee).

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr W. D. Sheers, "Electric Trams *v.* Motor Buses."

At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Mr. C. W. Salt, Chairman's Address.

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 10 a.m. The Right Hon. Lord Melchett, Presidential Address, Sir Henry Fowler, "Fuel Conservation in Locomotive Practice." Three papers dealing with "Economics of Coal Production and Distribution"—(1) Mr. G Raw, "Production"; (2) Prof. H. Louis, "Preparation"; (3) Captain R. Addy, "Marketing."

Geological Society, Burlington House, W. 5.30 p.m.

Imperial Institute (Cinema Theatre), South Kensington, S.W. At 10.15 a.m., 11.35 a.m., 2.15 p.m. and 3.35 p.m. "India"

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. (1) Dr. F. J. W. Whipple, "On the Association of the Diurnal Variation of Electric Potential Gradient in Fine Weather with the Distribution of Thunderstorms over the Globe." (2) Mr. N. K. Johnson, "Atmospheric Oscillations shown by the Microbarograph." (3) By Mr. H. Jameson, "On the Mean Maximum Rain falling in a Timet."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Miss K. M. Carter, "Ovule Development and Meiosis on *Orobanche Minor*"; Dr. W. H. Van Seters, "Tripod and Pillar Microscopes."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Prof. Sir Thomas Oliver, M.D., "Lead Poisoning in Industries."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. E. V. Appleton, "The Indebtedness of Industry to Pure Science." (Lecture VI—"Electrical Communication and its Indebtedness to Physics.")

At the London School of Economics, Houghton Street, W.C. 5.30 p.m. Rt. Hon. Sir Halford Mackinder, "The Future of Transportation."

6 p.m. Mr. J. L. Fenton, "Sundstrand Adding and Book-keeping Machines."

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Dr. L. D. Barnett, "Wit and Wisdom in Ancient India."

At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lirica del Paradiso" (Lecture III.)

5.30 p.m. Dr. Paul Stamberger, "Colloid Chemistry and its relation to the Rubber Industry." (Lecture V.)

5.30 p.m. Prof. Dr. J. G. Robertson, "Swedish Romanticism." (Lecture III.)

5.30 p.m. Mr. W. C. Berwick Sayers, "A Modern Public Library at Work."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Early Distribution and History of the Slavs." (Lecture I.)

THURSDAY, NOVEMBER 22..Abattoir Society, Model, at the Royal Veterinary College, Great College Street, N.W. 5 p.m. Prof. F. T. G. Hobday, "A Survey of Humane Methods of Destruction, including the Use of the Lethal Box for small Animals." (Benjamin Ward Richardson Memorial Lecture.)

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Major T. M. Barlow, "Weight of Aircraft, with special reference to its Effect on Size."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Birth Control and Racial Progress, Society for Constructive, at the Essex Hall, Strand, W.C. 8 p.m. Dr. Marie Stopes, Presidential Address, "Details from 10,000 Birth Control Cases."

Chadwick Public Lecture, at the Guildhall, Bath. 8 p.m. Dr. E. P. Cumberbatch, "Physio-Therapy, with special reference to Medical Electricity."

Electric Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. L. G. H. Sarsfield, "The Electrical Equipment of X-Ray Apparatus." (Joint Meeting with the British Institute of Radiology.)

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 10 a.m. Symposium on "Fuel Control in Industry." Morning: Dr. Ing. F. Munzinger, "Electric Power Stations." Dr. E. S. Grummell, "The Chemical Industry." Messrs A. J. Dale and A. T. Green, "Ceramic Industry." Dr. Geoffrey Martin, "The Cement Industry." Mr. T. A. Peebles, "American Practice and Experience." Mr. James R. Edwards, "Practical Results of Fuel Control." Afternoon: Mr. Martin J. Conway, "Liquid Fuel in Open Hearth Practice." Mr. J. L. Bentley, "Fuel Control in Open Hearth Practice." Mr. H. C. Armstrong, "Fuel Control in Re-heating Furnaces." Mr. J. B. Fortune, "Fuel Control in Blast Furnace Stoves."

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr Ingleson C. Goodison, "Woodwork of the Walnut Period."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. E. D. Adrian, "The Mechanism of Nerves."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Prof. Eccles, "Pierre Corneille" (in French). (Lecture VIII.)

At King's College, Strand, W.C. 5 p.m. Dr. W. Robson, "Protein Metabolism" (Lecture IV.)

5.30 p.m. Dr. J. C. Hearnshaw, "Rousseau"

5.30 p.m. Mr. J. Isaacs, "Bunyan as Literary Artist." (Lecture III.)

5.30 p.m. M. Marcu Beza, "Roumanian Literature."

5.30 p.m. Mr. A. F. Meyendorff, "Tolstoy as a Social and Political Reformer."

At University College, Gower Street, W.C. 5.15 p.m. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 150-750 A.D." (Lecture IV.)

5.30 p.m. Prof. R. Coupland, "The After Effects of the American Revolution on British Policy." (Lecture I.)

5.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt." (Lecture I.)

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk Mirsky, "Tolstoy" (Lecture VII.)

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr Eric Maclagan, "The Sculptors of the XVth century." (I)

FRIDAY, NOVEMBER 23 Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7.15 p.m. Mr. R. Brooks, "Electric Traction on Railways."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) Dr. G. Temple, "The Physical Interpretation of Wave Mechanics." (2) Mr. Allan Monkhouse, "The Effect of Superimposed Magnetic Fields on Dielectric Losses and Electric Breakdown Strength." (3) Mr. Albert Campbell, "A New Potentiometer of Larson Type." (4) Prof F. F. Herroun, and Prof. E. Wilson, "Ferromagnetic Ferric Oxide." A Demonstration of Emulsions showing Chromatic Effects by R. H. Humphrey.

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof E. Allison Peers, "A Century of Catalan (1829-1928)." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Mr. C. J. Gadd, "Assyrian Studies in the Past."

5.30 p.m. Dr. Edgar Prestage, "Afonso de Albuquerque, Governor of India."

5.30 p.m. Mr. G. B. Harrison, "Elizebethan Melancholy."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Collapse of Austria-Hungary." (Lecture VII.)

SATURDAY, NOVEMBER 24..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Ancient Egyptian Mummies."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. G. Whittaker, "North Country Folk Music." (Lecture II.)

United Service Museum, Whitehall, S.W. 3.30 p.m. Commander H. M. Denny, "Destroyers in the Great War."

JOURNAL OF THE
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No. 3966. VOL. LXXVII.

FRIDAY, NOVEMBER 23rd, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, NOVEMBER 26TH, at 8 p.m. (Cantor Lecture.) FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, "Biology and Refrigeration." (Lecture III.)

TUESDAY, NOVEMBER 27TH, at 4.30 p.m. (Dominions and Colonies Section) COL. H. L. CROSTHWAIT, C.I.E., "Air Survey and Empire Development." SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

WEDNESDAY, NOVEMBER 28th, at 8 p.m. (Ordinary Meeting.) J. H. ESTILL, O.B.E., Commercial Manager, Port of London Authority, "The Port of London." THE RIGHT HON. THOMAS WILES, P.C., will preside.

COUNCIL.

A meeting of the Council was held on Monday, November 12th. Present :—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Atul C. Chatterjee, C.I.E.; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir Henry A. Miers, F.R.S.; Sir Francis G. Ogilvie, C.B., LL.D.; Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S; Col. The Master of Sempill; Mr. James Swinburne, F.R.S.; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary) and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society :—
Abel, John Stewart, B.Sc., Buenos Aires, Argentine.
Bex, Frederick George, London.
Bianco, Silvio D., London.
Fletcher, C. H., London.
Garg, Ganga S., Gwalior, Central India.
Godfrey, Frederick, Matlock, Derbyshire.
Griffiths, Thomas Henry, London.
Hiles, Henry Edward, Sibford Ferris, Oxon
Kinred, Captain Hugh Cowell, M.C., London
Sanderson, Harold, Denham, Bucks.
Varma, P Deveshwar, Rawalpindi, India.

Mr. P. Morley Horder, F.S.A., was elected a Vice-President of the Society and a member of the Council in place of Sir Frank Baines, K C.V.O., C.B.E., resigned on the ground of ill-health.

The report of the Departmental Committee on Examinations for Part-Time Students was considered.

Authority was given to complete the purchase of the eight cottages known as Arlington Row, Bibury, Gloucestershire.

The arrangements for the latter portion of the session were further considered.

A quantity of financial and formal business was transacted.

SECOND ORDINARY MEETING.

WEDNESDAY, NOVEMBER 14TH, 1928. THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A , in the chair.

A paper entitled "English Silver and its Future" was read by MR. OMAR RAMSDEN, R.M.S. The paper and discussion will be published in the *Journal* on November 30th.

CANTOR LECTURES.

MONDAY, NOVEMBER 19TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the second of his course of three lectures on "Biology and Refrigeration."

The lectures will be published in the *Journal* during the Christmas recess.

BINDING COVERS FOR JOURNALS.

For the convenience of Fellows and others wishing to bind their annual volumes of the *Journal*, cloth covers can be supplied, post free, for 2s. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, NOVEMBER 9TH, 1928.

SIR HUGH T. KEELING, C.S.I., in the Chair.

THE CHAIRMAN, in introducing the reader of the paper, said he had done very distinguished work for the City of Madras in connection with water and drainage works.

The following paper was then read :—

TOWN WATER SUPPLY IN INDIA.*

By J. W. MADELEY, M.A., M.Inst.C.E., M.Am.Soc.C.E., M.Inst.W.E.

INTRODUCTION.

To-day we are to consider the supply of water to Indian towns.

The Madras Waterworks will frequently be referred to, because they are the waterworks that I know best in India, as it was my privilege to be responsible for their design, construction, and maintenance until they could be handed over as a going concern. They comprise nearly everything to be found in municipal waterworks in a typical Indian town. Reference will be made to British practice as occasion arises.

1. GENERAL CONDITIONS OF INDIAN TOWNS.

The large towns of India are situated in the Plains of a tropical country. Owing to the heat there is, for most of the year, a demand for water so great that it can hardly be appreciated in this country.

The people being poor, as measured by European standards, the Government usually pays half the cost of the works, and lends the remainder on generous terms. Even so, the funds are often inadequate for the supply required. These conditions cause the water supply problem of India to differ from that of England, where the people are generally better off and the climate cooler, and still more from that of America, where the population is the richest in the world and comparatively sparse, and where the quantity of water available is large.

Briefly, in the West the supply is usually regulated by the demand. In India it has to be adjusted to the quantity that the available funds can provide, and, as a result, there are few towns that can be supplied with as much water as they want. For instance, in Madras for twenty-four hours we endeavoured to supply the city with all the water it wanted, and although we did not quite

* Certain parts of the Paper as delivered have been omitted as they would be unintelligible without the lantern slides which were used to illustrate them.

succeed, the consumption was $23\frac{1}{2}$ million gallons. All that can be supplied regularly is $16\frac{3}{4}$ million gallons a day, and that quantity was not intended to be reached till 1966. Thus the city has less water than it wants. The same is true of nearly all large Indian towns, and consequently the equitable distribution of the water is much more difficult in India than in Europe.

Most large Indian towns were originally, and many still are to a great extent, supplied with water from shallow wells and tanks. As the towns grew in size, the wells and tanks became contaminated with filth, especially the tanks where ablution was performed in the same water that was used for drinking. As a result the water supply became seriously contaminated, and a very high death rate ensued from cholera, dysentery and other water-born diseases. The Indians accepted these epidemics as visitations of Providence, and did little to stop them.

As the British obtained control of the country, they endeavoured to raise the sanitary conditions of the towns to the level of those prevailing in British towns, but found great difficulties, the principal of which were the callousness of the people, and their comparative poverty, which made it difficult to carry out works on Western lines. I have referred to the attitude of the people as callous; in reality it was at first hostile, on the ground that water that came through a closed channel, such as a pipe, would be unwholesome. This opposition was at first quite strong in Madras, but when the advantages of piped water became apparent, a strong demand arose that every house should be connected with the new system.

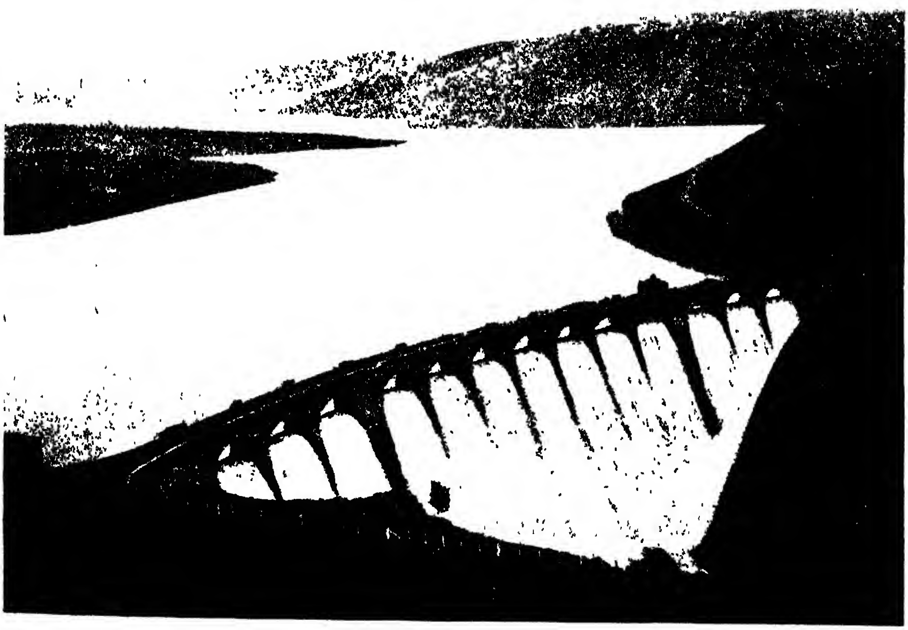
An amusing example of another attitude towards piped water was brought home to me when I was lecturing on water supply at a town some fifty miles south of Madras. After the lecture there was a discussion which disclosed that the general opinion was that a piped water supply was all very well in its way, but if it were provided for this particular town, what would the women do during the evening hours, which were then occupied in carrying water from the irrigation channels in earthen vessels? They gossiped enough as it was; what would they do if they had all this extra time?

2. Water a Valuable Commodity.

In England it is already becoming recognised that the supply of water, before long, will be insufficient to meet the demand if the latter continues to increase, as it has done of late years, through the introduction of baths and hot and cold water into all classes of houses, and it will soon be necessary to have recourse to sources which have hitherto been considered too polluted to be used for domestic supplies. Even in America the same problem is threatened in a few towns, owing to the large consumption due to having a separate bathroom for every bedroom in all the new hotels and living houses.

If this difficulty is felt in England and America, how much more must it be considered in India with its teeming population and its tropical climate,

making large quantities of water desirable for bathing and cleaning, and also for irrigation. Unfortunately the magnitude of the demand was not appreciated when the pipe water supplies were first introduced into the large cities of India. The supplies have been given on the lines of those of English towns. So far as I am aware, no town of the Plains of India has yet been able to supply as much water as the inhabitants desire. Bombay consumes about 60 gallons per head, Calcutta about 80, and yet both these towns are short of water. They are both spending large sums to increase their supplies, but I venture to think that these supplies will never be considered adequate by the inhabitants until it is appreciated that water is a valuable commodity,



Craig-Goch Dam.

and should be treated as such. Like gas and electricity, it should be supplied by meter and paid for according to the quantity used; the monthly bill would then act as an automatic check on waste, and if waste were eliminated, there should be enough water for all legitimate purposes.

3. Alternative to Universal Metering.

Such a policy involves the universal metering of connections unless steps are taken to ensure that non-metered connections are made in such a manner that they cannot take more than their fair share of water. Acting on this principle, the following system has been worked out for Madras.

In very poor districts where the habitations are mostly mud huts, water is supplied only through fountains provided with self-closing taps. The fountains are about 200 yards apart, and from them water can be obtained and carried in vessels to the huts. Experience shows that the limited number of taps and the effort of carrying the water severely restricts the quantity used.

For brick houses two classes of services are provided :—

(*a*) *A first-class service*, for which the consumer is required to hire water meters from the Corporation, to adopt only specified fittings, and to secure approval of the position and number of pipes, taps and other fittings.

(*b*) *A second-class service*, in which the consumer is allowed to fix one ½-inch tap of approved pattern provided it is placed in a position, approved by the President of the Corporation, that is visible from the road, and can at all times be readily inspected by the Municipal staff. No supply pipe for a second-class service shall be of a larger bore than ½-inch.

The city imposes a Water Tax on property. Beyond this, no charge is made for water supplied through a second-class service. In first-class services the tax is taken to cover 100 gallons per rupee of rent. A charge of one rupee is made for every additional thousand gallons of water used.

These regulations were adopted by the Corporation and proved effective so long as they were carried out, but unfortunately exceptions were granted by the Council in such numbers that the regulations ceased to be effective and the control of the Madras supply has been, thereby, rendered very difficult. One reason for this difficulty is that caste men greatly dislike anyone of lower caste entering their houses.

I well remember going to see the house service of a Brahmin, who had complained that it was out of order. I went at my usual inspection hour, i.e., seven o'clock in the morning, but was informed that I could not be admitted because of some religious ceremony that was in progress. I went away, leaving word that I would return at 10.30, on my way to office. I did so, and was again informed that I could not be admitted because the ceremony was still going on. I, thereupon, told the owner, who had been brought to see me, that I should immediately cut off the supply to the house, and not restore it until I had made the inspection. He, thereupon, asked me to come in and see it at once! This shows that there was really no objection to my inspecting the water connection. If such difficulty is experienced by the head of a Department, it may be imagined what may be the difficulties of the ordinary inspector in cases where the owner does not wish him to see his water-wasting taps, and will give him two annas to go away.

4. Sources of Water.

Wells. To obtain underground water the most usual method is to sink a well, and most of the towns of India obtained their original supplies from shallow wells which became contaminated and dangerous as the towns

expanded. This method is very seldom used for new waterworks for Indian towns and no description will be given here.

Infiltration Galleries. There is, however, another method of obtaining subterranean water which is not unfrequently used in the Madras Presidency, viz., by means of Infiltration Galleries in gravel or sandy river beds which are dry for a large part of the year.

In such cases there is frequently an underground flow which may be intercepted, and for this purpose an infiltration gallery, constructed across the line of flow, is suitable. The gallery is formed by digging a trench in the bed of the river to the length and depth decided on, and laying open-jointed stoneware pipes in the trench, which is then re-filled with layers of broken stone or gravel next to the pipes, followed by layers of stone and sand, so

Tamarapakkam Anicut.

graded as to prevent sand from entering the pipes. Thus the gallery is a prism of sand and stone with the pipes near the bottom. The pipes lead to a circular masonry well sunk in the river bank. To this the water flows, and from it is pumped to the town.

Such a gallery is used for the water supply of Conjeeveram, about forty-five miles south-west of Madras. The old supply, obtained from shallow wells and tanks, was far from satisfactory, and when the works fell into disrepair, it was decided to abondon them and obtain a supply from the River Begabathi by means of an infiltration gallery.

A site judged to be as unpolluted as possible was selected, and a trench 560 feet long, 8 feet wide and 18 feet deep was dug across the river; the gallery was constructed as above described, the top of the prism being level with the lowest ascertained summer water level which is 10 feet below the average bed

level. The whole of the infiltration prism is thus permanently saturated. At the bottom of the prism are four rows of 9-inch stoneware pipes, with open joints, terminating in a chamber close to the edge of the river. From this chamber the water is carried through an 18-inch pipe to a suction well on the bank of the river.

The works, which were opened in 1897, were designed to supply a population of 56,000 with 15 gallons per head per day. The infiltration gallery is stated to have cost only £1,200, but those were days of cheap labour and a cheaper rupee.

5. POPULATION TO BE SUPPLIED.

The first step in determining the quantity of water required is to ascertain, as precisely as possible, the population to be supplied. In considering this question, it is necessary to decide what future increase shall be allowed for, so as to provide for future demands without imposing an undue burden on the present taxpayer.

In India, waterworks loans are subject to repayment over a period of from thirty to fifty years, according to the nature of the work, and thus it is necessary to estimate the population at some forty years after the works come into use so that the needs of the consumers may be provided up to the end of that period.

A study has to be made of all the census returns available and the possibilities of industrial development, so that the probable growth of the town, both as a whole and in its different divisions, may be estimated. The growth as a whole is required for the main works; the growth in divisions is required in order to determine the sizes of the mains required to supply the different divisions of the city.

It is interesting to observe that in Madras the increases for a period of forty years varied from 6.6% in the heart of the city to 114% in one of the suburban areas. These figures show how important it is to consider each area separately.

If a uniform rate of increase had been adopted throughout the City, the pipes would have been too small in some areas and unnecessarily large in others.

6. QUANTITY OF WATER PER HEAD.

Having determined on the population to be supplied it is necessary to decide on the quantity of water required per head.

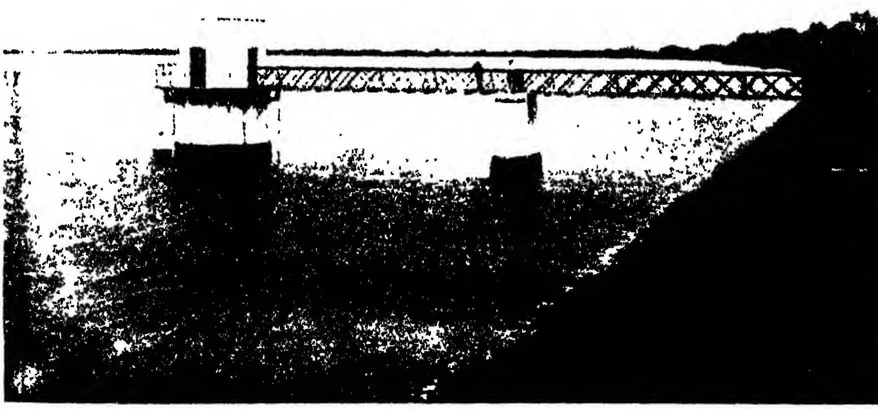
The consumption of water in Indian towns varies greatly. Thus we have Calcutta consuming 80 gallons per head per day and Bombay consuming 60 gallons per head per day.

But these amounts are very high compared with the average town where 30 gallons per head per day is about a maximum. In the Madras Presidency, 15 gallons per head per day is usually provided where at all possible. In communities where water is supplied through street fountains provided with properly looked-after self-closing taps, 5 gallons per head per day is found sufficient.

In the case of Madras City, after careful consideration, including, of course, the funds that were likely to be available, the writer, with the assent of the Government and the Corporation, worked out his scheme on a basis of 25 gallons per head per day. The population to be supplied at the end of the period for which the Government loans would be issued, was estimated at 660,000. Therefore, the quantity required is 660,000 x 25, i.e., a total for the city of 16½ million gallons per day.

7. DETERMINATION OF QUANTITY OF WATER AVAILABLE.

The quantity of water that can be obtained from any catchment area is the total rain that falls on the area, less that which escapes by percolation and evaporation, so that if the rainfall is measured, an estimate of run-off can be



Inlet Tower at Red Hills Lake, at beginning of the Madras Waterworks.

made in terms of the average rainfall which should be calculated over a considerable period, twenty-five years or more, if possible. The rainfall is determined by rain gauges placed at suitable positions in the catchment. If these have not already been established before the investigation is begun, the necessary gauges must be fixed as early as possible and their records carefully compared with pre-existing rain gauges on the catchment or neighbouring catchment, so that the falls at the new rain gauge positions may be determined in relation to the falls of the old rain gauges. It is usual to build reservoirs to equalise the flow of three dry years, and, therefore, the rainfall over three consecutive dry years is estimated by experts conversant with the meteorology of the district. The following example will show how the yield is calculated :—

Suppose the average annual rainfall is	45	inches.
Deduct one-fifth (say)	9	,,
	—	
Average for three dry years	36	,,
Loss by evaporation and percolation (say)	14	,,
	—	
Available rainfall for storage	22	,,

Suppose the area of the watershed is 2,130 acres, then the available yield

$$= \frac{22}{12} \times 2{,}130 \times 4{,}840 \times 9 \times 6\frac{1}{4} \times \frac{1}{365}$$

= approximately 3 million gallons per day.

By a calculation such as this the available yield can be estimated.

The method described is often the only one available for preliminary calculations, but as soon as possible, actual measurements of discharge should be made by fixing gauges on the streams of the catchment. With the yield accurately measured, the size of the reservoir can be determined graphically by plotting, in terms of time curves representing the total yield and total supply for the longest period for which data are available.

8. Slow Sand Filtration.

Practically all water supplies to Indian towns are subject to pollution, which may be dangerous. Some form of purification is, therefore, necessary. The most usual in this country and which, until recently, has been most usual in India, is slow sand filtration, which was introduced in England by Simpson, engineer of the Chelsea and Lambeth Water Company, just one hundred years ago. The filters he used are very similar to the slow sand filters of to-day, which consist of fine sand supported by coarser sand and gravel, through which are laid drains to convey the filtered water to tanks. The original purpose of these filters was to strain out the dirt and supply clear water, but after they had been in operation for some time it was found that the persons using filtered water were much freer from water-born diseases than persons who used raw water, and bacteriologists subsequently showed that slow sand filters, if properly run, would remove some 97% of the organisms in the water.

In addition, it has been found that storage up to about 30 days in England, and about 7 days in India, will remove a large percentage of the organisms, so that storage followed by slow sand filtration produces a very good water, where the conditions are suitable, and it is this method which, until recently, has been the standard for large towns in England and India, including the two largest—London and Calcutta.

The benefit derived from filtration is well shown in the case of Zurich, where there is considerable pollution of the raw water. To overcome this, slow sand

filters were introduced, and the typhoid death-rates in Zurich were reduced from an average of 73.6 to 9.0 per 100,000 population. What is probably the most notable example of the benefit of slow sand filtration is afforded by the cholera epidemic that visited Hamburg and Altona in 1892. Hamburg, with a population at that time of 640,000, and Altona with 150,000, are situated on the same bank of the River Elbe near its mouth. They form practically one city. At the date of the epidemic Hamburg drew its water supply, which

Madras Waterworks. Construction of Conduit.

was unfiltered, some distance above the city, while Altona took the same river water at a point eight miles down stream, *i.e.*, after it had received the pollution of the 800,000 inhabitants of the joint cities, but Altona's water was filtered. In Hamburg there were 8,600 deaths in less than two months, and in Altona about 300 deaths during the same time, and many of these were cases imported from Hamburg. Altona, using a highly-polluted water which had been filtered,

suffered very much less than Hamburg, using a much less polluted water which had not been filtered. The lower death rate in Altona can only be attributed to the use of the slow sand filters.

It is very important for the proper action of the filters that the water should be introduced on the surface at a uniform rate, and in such a manner that the surface film is not disturbed, otherwise the efficiency of the filter is impaired.

After a time, the surface film becomes so dense that the rate of filtration cannot be maintained. The filter is then emptied and the surface scraped. The surface of the filter dries up, the filtering skin curling into sheets which are removed by hand by women coolies. This skin is used for manure. Under it is a gelatinous layer of sand which is removed by means of "mamooties" and taken to be washed so that it can be used again.

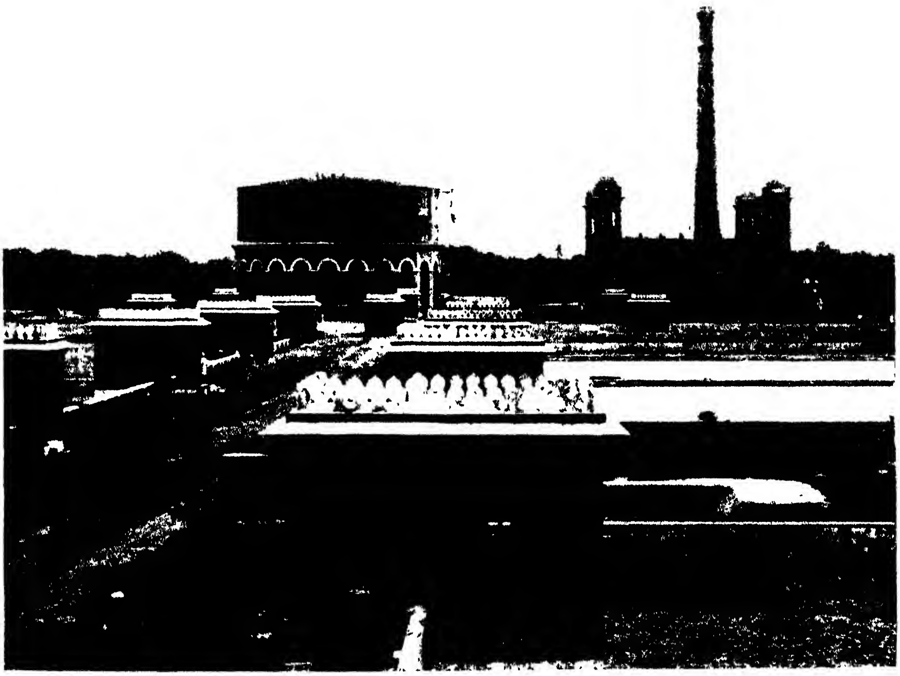
It is this gelatinous layer which is the essential part of a slow sand filter. The function of the sand is to form a framework which carries the gelatinous matter developed in the bed. The water passes readily through the jelly-like material, but the finest matter, even as small as bacteria, is held up.

In order that the gelatinous layer may be kept intact and not broken it is very important that the rate of filtration should be kept constant and should not exceed a speed which with most waters is 4 inches vertical per hour. The regulation is best effected at the filter outlet, where an automatic regulator may be fixed. As used in Madras, each of these regulators consisted of an outlet pipe 14 inches in diameter, capable of sliding up and down inside a closely-fitting cast iron pipe finished with a flat base. This has a right-angled branch through which the filtered water passes to the Filtered Water Conduit. At its top the sliding pipe is fitted with two weirs, each 15 inches long, attached to galvanised iron float tanks, so arranged that the weirs are maintained at a constant depth below the water and that the outlet can be made to discharge continuously at a predetermined rate. A screw is provided, by which the telescopic pipe weirs can be raised or lowered, relative to the floats, thus reducing or increasing the rate of filtration.

9. PRE-FILTRATION TREATMENT OF WATER.

The filter described above is not suitable for all waters, and some form of pre-treatment is frequently necessary. Most large rivers contain silt, which has to be removed in order to render the water suitable for filtration, the usual process being by sedimentation in large tanks, either with, or without, the use of chemicals. A notable instance of this preliminary sedimentation is afforded by Calcutta, where four tanks are provided each 2,036 feet long, with an average width of 277 feet and with a total capacity of 84 million gallons. The result of this treatment is three-fold: firstly, the sediment is removed to a very large extent; secondly, in settling, the sediment carries down a large quantity of organic matter; and, thirdly, the number of organisms is much reduced. Precipitation is obtained by adding alumina feric and

lime, with three days' sedimentation during the rainy season, and two days' sedimentation only during the dry season. With a silty water, such as that of Calcutta, this method is quite suitable as a pre-treatment for filtration through slow sand filters, and in the new works nearing completion, its use is being extended by the addition of two brick pre-settling tanks 200 feet wide and 100 feet long with three cross walls to save the cleaning of the settling tanks.



Madras Waterworks Filter Beds with Control Houses in the foreground, and Pumping Station and Elevated Tanks in the background.

10. Double Filtration.

Another method of pre-treatment is to pass water first through rapid filters about 50 times as fast as through slow sand filters, thus removing a considerable quantity of the suspended matter, and to pass the effluent on to the slow filters. This method, as worked out by Sir Alexander Houston, has recently been used by the Metropolitan Water Board for part of the London supply, and is reported to be highly successful as an economic method of treating Thames water.

Experiments proved that with the Madras water double filtration would not be satisfactory unless alum were used, and if alum were used, no second filtration was necessary.

11. FAILURE OF SLOW SAND FILTRATION IN MADRAS.

There are, however, cases where the cost of pre-treatment to render the water suitable for slow sand filtration would be too great to make it an economical method of producing a good water. This seems to be especially the case in India, where slow sand filtration has not proved altogether satisfactory in a number of towns. Madras is one instance. Here a filtering skin is duly formed, and for the first two or three months after starting, slow sand filters will work satisfactorily, but then analyses show loss of efficiency, and at the same time there is a smell of sulphuretted hydrogen in the neighbourhood of the filter outlet, and on emptying the filters, crater-like holes are frequently discovered in the surface. From careful observation it has been concluded that these are due to H_2S gas generated in the filter by organisms reducing the sulphates present in the water. This is confirmed by the fact that the crater-like holes and the irregularity in working only appear after the smell of sulpuretted hydrogen has become apparent at the filter outlet. Investigations showed that sulphuretted hydrogen was not formed with a rate of 8 inches per vertical hour or more, and it might therefore be supposed that to filter at this rate would be a solution of the trouble. The Madras water, however, contains organic matter in suspension of such a fineness as to be colloidal in character, and at higher rates of filtration than about 4 inches vertical per hour this matter is carried down into the sand to such a depth as to make washing the sand a serious mechanical problem, if the dirty sand has to be removed, washed, and replaced.

This obviously points to filters where the washing can be performed without removing the filtering materials, and the writer has recommended that the present slow sand filters should be converted into sedimentation tanks and rapid filters working at the rate of 100 inches vertical per hour with a chlorinating plant to be used as bacteriological analysis shows desirable. This might be continuously.

12. RAPID FILTERS.

Poona may be mentioned as another town which has changed from slow sand filters to rapid filters, and a number of towns in the north of India are doing the same. The essential film on the surface of the slow sand filters forms *slowly* by the deposition of matter in the water. With rapid filters an artificial film is formed *rapidly* by adding a coagulant, usually alum, or alum and lime, to the water. The gelatinous material produced passes well down into the sand and forms so strong a filtering layer, that water can be passed through at a very much higher rate than with the natural film of slow sand filters. Rapid filters have the advantage that, owing to the high rate at which the water is passed through them the area is small, and the filtering materials can be cleaned in place by means of an upward flow of water. Before filtration the water should be passed through sedimentation tanks, where a coagulant

may be added as required. After leaving these tanks, the water is treated with a dose of alum, in alum mixing tanks, and then passed on to the rapid filters.

On p. 41 is an illustration of a rapid filter installation which has been kindly supplied by Mr. Paterson, who has installed many rapid filters in India, including a set on works for which I was responsible.

The gravity type of mechanical filters are open at the top and the filtering head is provided by the difference in level between the inlet and outlet. The gravity type alone is usually employed for Indian town water supplies, for the water is nearly always dangerous or potentially dangerous. Where, however, the water is coloured but is reasonably safe, pressure filters can be employed. These are cylindrical steel chambers containing filtering materials, and are connected with the pumping main so that the water can be forced through the filter by the pressure in the main. The chemicals are added just before the water enters the filters. Hence the filter itself cannot be examined while in use and is not under the same control as the gravity filter.

For the purification of water for Indian towns the present tendency is to use sedimentation with or without chemicals, followed by Rapid Filtration. This method is used at Delhi, Lucknow, Allahabad and Poona. It has been recommended for Madras and Bombay, and only this week I have heard that, on my recommendation, it is to be installed at Trivandrum, the capital of the State of Travancore.

13. CHLORINATION.

However carefully sand filters are worked it is essential with many waters which are potentially dangerous, such as that of Madras, to secure another line of defence and that fortunately lies to hand in chlorine, which added in sufficient quantity will destroy all the organisms in the water. Originally chlorine was applied in the form of bleaching powder, and this still remains a very useful method in cases of emergency. Owing to the variation in the quantity of the available chlorine it contains, largely due to its instability, the necessary mixing, and the sludge which results when it is employed, it has been found better to use chlorine gas, which can be obtained pure and can be stored in steel cylinders so as not to be subject to atmospheric conditions. With the recently-designed apparatus, the desired dose of chlorine can be added with great precision. In India the "Chloronome" manufactured by the Paterson Engineering Company is the most commonly used instrument for regulating and administering chlorine gas to the water.

The steel cylinders containing liquid chlorine are connected directly with the Chloronome apparatus, and the chlorine passes in gas form to a filter which removes any dirt there may be in the gas, and then through two pressure reducing valves which maintain a constant pressure on the regulating valve.

The chlorine gas passes the regulating valve and flows through the meter down a central pipe to near the bottom of the absorption column which contains

a water-distributing tray and is packed with pumice. A small trickle of water is uniformly distributed over the pumice in its downward passage and absorbs the measured quantity of chlorine gas. The chlorinated water flows out from the bottom of the column to the main body of water to the sterilised.

It is nearly always preferable to add the chlorine to the filtered water in preference to the raw water, because the filtered water has a smaller, and more constant organic content than the raw water, so that the chlorine dose can be more closely regulated, and there is less danger of taste and smell. In some cases, however, it is necessary to add chlorine before filtration, and sometimes both before and after, depending on the nature of the water.

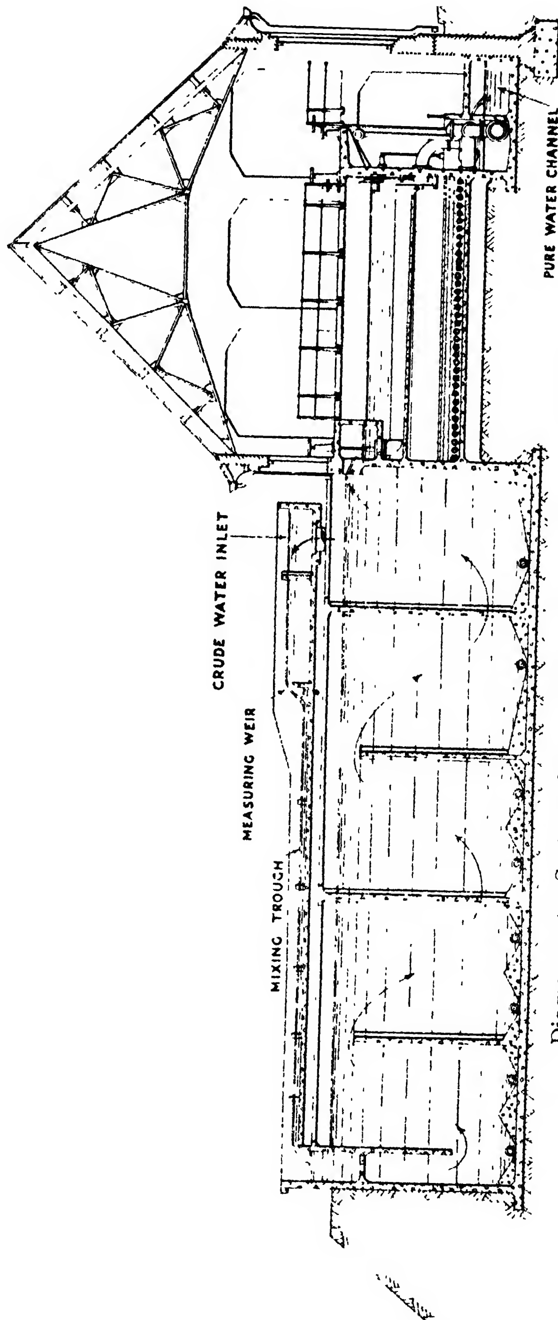
In America chlorine is used sometimes as the only treatment, and in India, so large a town as Bombay is at present relying on chlorine alone to purify its water. There is no doubt, however, that for water containing organic matter in suspension, chlorine should be regarded as supplementary to filtration not as a substitute for it.

14. Filtered Water Tanks.

After purification, the water flows to filtered water tanks, which are usually below ground level. If by good fortune the filtered water tanks can be constructed at such an elevation as to be able to feed the town by gravity, the water may be taken directly from them into the distribution system. Almost universally, however, the level is too low for the town and pumping is required. In that case the filtered water tanks serve as a balance between the filters and the pumps so that the filters may work at a uniform rate night and day, while the pumps more or less follow the fluctuations of demand, pumping more than is filtered during the daytime and less during the night.

15. Pumping Station and Elevated Tank.

Assuming, therefore, that pumping is required, the filtered water tanks are connected to the sump of the pumps. In the Madras Pumping Station are three high duty pumps, each capable of raising 12,000 gallons per minute, which is the average rate of supply; two will deal with the maximum supply, and the third is a stand by. There is also a large Steel Elevated Tank to maintain a balance between the pumps and the demand for water for the distribution system. When the quantity of water pumped is greater than the consumption, the tank will store the excess, and will supply it to the city when the consumption is in excess of the quantity pumped. The tank is circular in plan, 104 feet in diameter, 28 feet deep from the overflow level to the flat bottom, and has a capacity of 1½ million gallons. In order to maintain an adequate pressure all over the city, the tank has been designed with its bottom 37 feet and the top of roof 73 feet above ground level.



Diagrammatic Section through typical Rapid Filtration Plant.

16. Distribution System.

The essential requirements of an efficient distribution system are :—

(1) To supply all consumers with an adequate quantity of water during the day.
(2) To maintain a sufficient pressure throughout the distribution system.
(3) To ensure perfect and rapid circulation of water throughout the entire system.
(4) To provide reasonable protection against fire.
(5) To provide means of detecting and stopping waste in a systematic manner.

17. Maximum Rate of Supply.

The average rate of supply has to be determined for the main works, but for the distribution works it is necessary to determine the maximum rate of consumption, in order that the pipes may be designed of a suitable size. Thus, in Madras, where the average supply was taken at 25 gallons per head per 24 hours, an additional 20% was added for the hot weather. A higher figure was not taken because during the hottest weather a large number of consumers are out of Madras at hill stations, in Europe, and other cooler places.

Experiments on the flow of sewage led to the conclusion that maximum consumption might be taken as 2.4 times the average rate of consumption throughout the day. Even this figure does not allow for water required for fires, new moon days, and other festivals, when especially large quantities of water are used for bathing and house cleaning. Account must also be taken of the decrease in carrying capacity of the pipes, which occurs with age. In view of these considerations, the distribution system was designed so as to be capable of supplying water at a rate equal to three times the average demand, i.e., 75 gallons per head per day. In case the maximum demand exceeds the estimate, or the carrying capacity of the pipes decreases more than anticipated, it is proposed that balancing tanks should be erected to control the areas furthest from the pumping station. The tanks would be used to store water during hours of low demand and render it available during those hours that the demand is greatest, thus greatly increasing the capacity of the distribution system.

18. Pressure to be Maintained.

The minimum pressure maintained in up-country towns in the Madras Presidency is about 10 feet above ground level. This is exceedingly low, compared with the usual practice in Europe and America; and Madras City, as the capital of the Presidency and the seat of Government, calls for something better. It was decided to provide a pressure of at least 50 feet above ground level at the ends of the principal mains, when the supply is at the rate of

25 gallons per head per day. This brings Madras into line with Bombay and Calcutta.

Unfortunately the Council have relaxed the rules and regulations which were formulated for the prevention of waste to such an extent that the Executive are no longer able to maintain throughout the City the pressure which was intended.

19. Arrangement of Pipes.

The water from the pumps is carried by a 48-inch steel main for a distance of about 3,000 feet to a point where it branches into the seven mains which supply the seven water divisions of the city. There are, in addition, ten sub-mains supplying areas, any of which can be isolated. The sub-mains are arranged so as to ensure good circulation and distribution, and to restrict the area affected in case of the failure of a pipe.

Every closely built-up district is encircled by mains, in order that the cross distribution pipes can be fed from both ends. Dead-ends are avoided wherever possible.

To obviate closing large mains and the consequent interference with the water supply of considerable areas, large pipes are not tapped for house connections, but instead "rider mains" are used, laid parallel to the larger main and connected to it at both ends. In the system as designed, rider mains were provided for all pipes above 9 inches in diameter. Owing to lack of money, consequent on the war, some have been temporarily omitted.

20. Prevention of Misuse and Waste of Water.

The prevention of misuse and waste of water is one of the most important problems that face an Indian municipality.

Perhaps the most important duty of a municipality is to provide an adequate supply of wholesome drinking water throughout the area it controls. To carry out this duty, the co-operation of the inhabitants in preventing misuse and waste is necessary.

When it is stated that a single hole in a pipe of the size of a pin-head may cause waste of sufficient water to supply 50 persons, and that a hole as large as a pencil would waste sufficient water to supply 750 persons, it is obvious that a number of small leaks will render insufficient a supply which would otherwise be perfectly adequate to the needs of the people.

Owing to misuse the most ample of supplies may fail to meet the demand. For instance, a single tap left open all day for watering a garden may deprive a thousand persons of the necessary water for domestic purposes.

Loss of water may occur through wilful waste and improper use or through leakage from mains, house connections and house fixtures. Only by constant work can the loss from leakage of pipes, defective fittings, and unsound pipes,

be kept within reasonable limits. The writer has himself seen in Madras house service pipes with gaping rust holes and main pipes almost eaten through by rust, and when water mains are bared, it is common to find numerous house services leaking, and many small leaks would account for a large total loss which will be quite invisible in porous soils, such as sand or gravel.

Not only do these holes cause loss of water, but they provide openings through which the impurities from the surrounding soil may be sucked in when the pipes become empty. Several cases of serious illness have been traced to this cause.

The methods of detecting waste usually used in an Indian city are :—

(1) Limiting the number of connections.
(2) Metering every water service.
(3) House to house inspection.
(4) Waste-water meter system.

These are all put into use in a number of Indian towns. Bombay and Calcutta may be cited as examples, but even in these towns, it has been impossible to limit the waste effectively. In Madras all these methods are in use, though so far the waste-water meters have not been installed as originally intended, because although contract forms had been prepared before the Great War began, no work had been ordered, and the financial position since the War has not been sufficiently favourable to allow the work to proceed.

21. CONCLUSION.

I have now reached the end of my Paper, and will conclude by saying that an ample supply of wholesome water has probably a greater influence than any other single factor upon the health of the community, but, if the fullest possible benefit is to be derived from a water supply, the co-operation of every water consumer is needed. The mass of the population require to be taught that they must husband water, and that waste or pollution of water is a crime against society. I trust that those of you who are here to-day, and who have any interest in India, will assist in educating the public opinion of that great country to a full appreciation of the fact that "wilful waste brings woeful want," so that he who wastes wilfully may be regarded as an offender against the community. A proper public opinion thus formed will be a force which will act as a stronger deterrent than any rules, regulations or fines.

My last words will be a quotation from an American engineer, who writes : " Perhaps the greatest folly of our time is the almost universal attempt of cities and towns to increase their water supply plant to keep pace with their waste. It is a hopeless task. It amounts to the same thing as attempting to fill a pail which has only a sieve at the bottom. The amount of water which can be used is limited. The amount which can be wasted has no limit."

DISCUSSION.

THE CHAIRMAN said they were much indebted to Mr. Madeley for the very informative and instructive lecture he had given that evening, and he wished emphatically to endorse his concluding remarks about the waste of water in India. All classes of people in India, Europeans and Indians, were incredibly wasteful of the water that they obtained; in fact, so much so that with possibly the exception of the United States he thought there was no country on the face of the earth where so much waste of water went on. He thought there were only two ways of controlling it: one was by a very extensive and careful system of metering on the distribution system, and the other—and possibly the more potent method—was to charge for what a man used. He had known Members of Council in Delhi object to their water bills, but the real facts of the matter was that the *mali* had left the tap running, and the demand made on the honourable member instead of being for a reasonable sum of money amounted to several hundred rupees for a month. When the reader was speaking about making dams in India he commented on the absence of plant for their construction. It was perfectly true that on the Periyar Dam, on which he (the speaker) had been a junior assistant engineer serving under a gentleman who was present that evening, Mr. Pears, the plant was conspicuous by its absence; practically in the early stages of the dam the only thing on the works was the ordinary centrifugal pump. That day was passed. In September last he went to see a scheme which was being tested for the placing of concrete in a dam which was now under construction in the Madras Presidency. The structure contained a mass of 1,800 tons of steel, and was 311 ft. high, and consisted of chutes and mixers and measuring drums and everything that was required for the mechanical treatment of concrete, the material being run in on trucks, lifted up by hoists, placed in the measuring drums and mixed in the various mixers and shot down on to the dam. That enormous structure moved under its own power; there were two of them, each operating from one flank of the dam. That great change in the method of construction was one of the consequences of the war. The ancient method of building dams in India took so long that a great deal of money went in interest charges, and in order to get rid of those as much as possible it was necessary to speed up construction, and the engineers in charge of the dam had adopted the expedient of using these enormous steel towers as a means of lessening the time required to construct the dam over the old methods previously in use in India. With regard to water pure and simple, he should have liked to hear from the reader some remarks about the cost of water per head. Before coming to the meeting he had looked up a few notes in his possession and had found that in some of the towns in Northern India—the United Provinces, for example—the cost of supplying water to the people in the towns, as given in the sanitary engineer's report at the time, was in Agra 3.8 annas, in Allahabad 3.6 annas, in Benares 3.5 annas, and in Lucknow 3.7 annas, which in English currency was round about fourpence per thousand gallons. It was well known what the charge in London was per thousand gallons, and there were towns in this country where the water charges were over two shillings per thousand gallons. In that respect, therefore, India was somewhat more fortunate than England. With regard to the capital cost, in three of the towns the capital cost of the works was somewhere in the neighbourhood of twelve rupees per head of population; in England at the present time the capital cost was between £5 and £7, instead of sixteen shillings, which twelve rupees then represented. When the new capital in Delhi was under construction an important system of water works was devised and sand filtration abolished and the Paterson filtration plant used. He would

not bother the meeting with a technical description of the plant itself, as that had been fully covered by the reader, but he should like to mention that for two years previous to his departure from Delhi absolutely sterile water was supplied to the people and it made the very greatest difference in the health of the population. The cost at which that water was supplied was a little over three annas per thousand gallons, which included half the capital cost but not the interest on the Government loan to the municipality. The actual cost, as originally estimated before the war, worked out to about 12.58 rupees per head, but, as the greater portion of the work was only carried out after the war, that cost was raised to about eighteen rupees per head of the population. Probably a similar water supply in other towns in Northern India would cost about the same per capita. The engineer had many troubles in the East when dealing with such problems, and one of the reasons which led to grumbling when water works were opened in India was very often the time taken from the inception of the project to its conclusion. He knew of a case where the water supply of the town was first talked about in the year 1870, and time went on until 1881, when the engineer in charge submitted a scheme based on the population of the town. The matter continued to be discussed until another gentleman succeeded the originator of the scheme, who was sent home in 1884 to consult an engineer in this country as to what should be done. He returned in six months' time and the discussion was continued. A slight modification was made, and the scheme was eventually sanctioned in 1889 and work was begun in 1890. Money was dribbled out in small handfuls and the work was eventually concluded in 1899. The population meanwhile had considerably increased, with the result that the original estimate of water per head of population was reduced by 25 per cent., and consequently there was grumbling. All cases were not as bad as that, but there was very often a considerable amount of delay in the various processes that had to be gone through from the time of the inception of the scheme until its conclusion.

Mr. C. H. Bompas, C.S.I., said that one of the greatest benefits in India was a wholesome water supply. It was not always welcome. One great fact about it was that it had no claim to sanctity, which was a great difficulty in a town like Benares or Calcutta. But once people had the supply they appreciated its value and insisted on having as much of it as they could, and more if possible. The manner in which it was appreciated was brought to his notice in rather an odd way in the case of a prisoner in the Alipore gaol, who, after serving a long sentence, was about to be released and objected. He said, "For years you have had me in this gaol and I have drunk nothing but filtered water drawn from a boiler which blows a whistle, and now you are sending me to my village where I shall have to drink water from the village tank and I shall be dead in a fortnight." In Calcutta, the champion water waster in India, they were aiming at a supply of 90 gallons per head, and the reader had said that 25 gallons was enough for people. Much water was wasted in Calcutta. The present supply was about 70 gallons per head, but 30 gallons was unfiltered and only used for road watering and flushing, leaving 40 gallons for domestic purposes. The first thing the Bengali did was to build a reservoir in his yard under his tap and to keep that reservoir full, and, as the water supply was not continuous, the next thing he did was to tie back the spring and waste taps so that the water ran, and as the constant noise of trickling water might be annoying he generally put a piece of split bamboo or cloth from the tap to the reservoir and left the water running day and night. The unfortunate result was that the people in the south of the town furthest from the supply tank were short of water because the people in the north had practically exhausted it.

Although they were told the water could be provided if the people in the north of the town did not waste so much, no one was prepared to go in for stringent measures by metering every house and making them pay for the water consumed. That was not practical politics. No member of the municipality would get support if he proposed anything like that. They had now gone in for a very large extension of the filtered water supply which was supposed to be going to solve the difficulty, because it was thought that if there was a really continuous supply, so that a man could turn the tap on at any time and get water, the people would be content and would not insist on having their taps left open. He did not know how far the remedy would be successful, but it was certainly an expensive one. For the credit of Calcutta he should say that it had one very remarkable feature about its water works. A photograph had been shown of an elevated tank in which the water was stored so that it might continuously flow into the pipes and act as a balancing factor between times of greatest and least demand. The great water tank at Tollah was one of the most remarkable engineering achievements in the water works line in the world. It was desired to keep a reserve to supply the enormous demand for water at rush hours, and it was necessary to build a tank on the same lines as the Madras one, except that in this case it was a steel tank over 100 yards square, 16 ft. deep, and standing on columns 100 ft. high. It held 40,000 tons of water. It filled up during the night but all the water was drawn out by people in a few hours in the morning. The engineer who designed it was a brave man. Everybody prophesied the tank would not stand up or that an earthquake would knock it down, but it had proved a great success and justified the engineer, and he should like Calcutta to get credit for it.

Mr. W. T. Burgess wished to thank the reader of the paper for the information he had given with regard to the difficulties that water engineers had to deal with in average temperatures, which were very much greater than those in this country. A good many difficulties were met with in India which were quite unknown in England. The reader had referred to one instance, the formation of sulphuretted hydrogen in the filtered water in spite of the rapid rate at which the water was used. About four vertical inches was the average rate for slow sand filters, but when twice that rate was wanted they had to get over the trouble which had been brought about by the rapid growth of organisms. The troubles in these days were not quite as bad as they used to be, because there were now possibilities of making water sterile and absolutely safe by the use of minute doses of chlorine, which was something to be thankful for. In days gone by there was a prejudice against using chemicals of any sort for the purification of water; even lime was objected to because it was a chemical. Sulphate of alumina was looked upon as an objectionable chemical. Chlorine came into use before the war to some extent and was looked upon as objectionable, but after the war many learned to become accustomed to chlorinated water and appreciated the smell of it, and now they knew that if the water had that smell it was absolutely safe and they were getting over the prejudice, although even to-day there was some objection to the use of chlorine. Every water engineer who had put in a plant had occasionally met with troubles, but those troubles and the cost of overcoming them were gradually becoming known and remedies were being found, and he thought in the near future there would be very few who would hesitate to use chlorine for the final purification of waters that left a little bit to be desired in their present condition.

On the motion of the Chairman, a hearty vote of thanks was accorded to the reader, who briefly responded. The meeting then terminated.

OBITUARY.

TREVOR B. SIMON. We regret to announce the death at Pittsburgh, Pennsylvania, on October 28th, of Mr. Trevor B. Simon, construction engineer of the Consolidation Coal Company. Mr. Simon graduated from the Ohio State University in 1907 and rapidly built up a high reputation as a mining engineer. He filled a number of important engineering posts, and, when the United States entered the war, did valuable service in the United States Army Ordnance Department. In 1921 he became President of the C. L. Miller Company, a position which he occupied until 1926. He was a member of the American Mining Congress, and of the American Institute of Mining and Metallurgical Engineers.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 26..Actuaries Institute of, at Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. R. Thodey, "Life Insurance in Australia."

Chadwick Public Lecture, at University College, Exeter. 7.30 p.m. Dr. P. B. Ballard, "Open-Air Schools."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. F. S. Ritter, "Picture Telegraphy."

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Informal discussion on "Automatic Network Voltage --Regulating Equipments."

University of London, at the Institute of Historical Research, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton Watson, "The Little Entente and its Policy."

At King's College, Strand, W.C. 5.30 p.m. Rev. Claude Jenkins, "Decline of Dogma and the Anti-Dogmatic Movement."

TUESDAY, NOVEMBER 27..Anthropological Institute, at Burlington House, W. 8.30 p.m. Prof. Sir Arthur Keith, F.R.S., "The Evolution of the Human Races." (Huxley Memorial Lecture).

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Informal Discussion.

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. H. W. Miles, "Agriculture of the Ormskirk Region."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. D. F. Campbell, "Electric Furnace Developments."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture II).

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VIII.)

At University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture III).

WEDNESDAY, NOVEMBER 28..Automobile Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Dr. E. C. Wadlow, "The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Informal Meeting. Exhibition of film of recent Canadian-American Tour.

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Dr. H. R. Hall, "Egypt and the External World in the Saite Period."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. Ordinary Meeting, 5 p.m.

Public Health, Royal Institute, 37, Russell Square, W.C. 4 p.m. Dr. H. M. Vernon, "The Fatigue of Heavy Industrial Work, and its Influence on Health and on the Duration of Working Life."

Science Guild, British, at the Goldsmith's Hall, Foster Lane, E.C. 4.30 p.m. Prof. J. Arthur Thomson, "The Culture Value of Natural History."

United Service Institution, Whitehall, S.W. 3 p.m. Captain L. D. I. MacKinnon, "The Work of the British Navy in the Far East."

University of London, at King's College, Strand, W.C. 5.30 p.m. Miss Doris L. Mackinnon, "The Indebtedness of Industry to Pure Science." (Lecture VII—"The Practical Applications of Zoology.")

At the London School of Economics, Houghton Street, W.C. 5 p.m. Rt. Hon. Sir Leslie Scott, "Proceedings by and against the Crown."

6 p.m. Mr. W. Dixon, "Dictating Machines."

At University C[...] Gower Street, W.C. [...] p.m. Dr. Camillo Pel[...] "La Lirica del Paradiso." (Lecture IV).

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Mr. N. B. Jobson, "The Early Distribution and History of the Slavs." (Lecture II).

THURSDAY, NOVEMBER 29..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. F. Sigrist, "Production Problems."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Prof. Dr. F. G. Donnan, "Physical Chemistry in the Service of Biology."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C., The Geffrye Museum, Kingsland Road, [...] p.m. Mr. John C. Rogers, "Craftmanship of the Early Mahogany Period."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. E. D. Adrian, "The Mechan[...] of Ner[...]" (Lecture II).

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Prof. Eccles, "Pierre Corneille." (in French). (Lecture IX).

At King's College, Strand, W.C. 5.30 p.m. Mr. W. H. Wickwar, "Helvetius and Holbach."

5.30 p.m. Mr. Henry Wickham Steed, "Roumania in the New Europe."

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 150-750 A.D." (Lecture V).

5.30 p.m. Prof. R. Coupland, "The After Effects of the American Revolution on British Policy." (Lecture II).

5.30 p.m. Mr. H. Warren Wilson, "English Decoration in the Seventeenth and Eighteenth Centuries."

8.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt." (Lecture II).

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Svyatopolk Mirsky, "Tolstoy." (Lecture VIII).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "The Sculptors of the XVth Century." (Lecture II).

FRIDAY, NOVEMBER 30..Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Prof. W. E. Dalby, F.R.S., "The Possible Vibration of a Ship's Hull under the Action of an Unbalanced Engine." (Thomas Lowe Gray Lecture).

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-upon-Tyne. 6 p.m. Dr. E. V. Telfer, "Frictional Resistance and Ship Resistance Similarity."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (1829-1928)." (Lecture IV).

At King's College, Strand, W.C. 5.30 p.m. Major H. W. V. Temperley, "Canning and Greece."

At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prof. Dr. R. W. Seton Watson, "The Collapse of Austria-Hungary." (Lecture VIII).

SATURDAY, DECEMBER 1..Association of Teachers of Speech Training, at the Royal Society of Arts, Adelphi, W.C. 10 a.m.

L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Montagu A. Phillips, "Bird Life."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. W. G. Whittaker, "The Violin Sonatas of William Young (17th Century)."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3967. VOL. LXXVII.

FRIDAY, NOVEMBER 30th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 3RD, at 4.30 p.m. (Indian Section.) SIR JAMES MACKENNA, C.I.E., "The Sugar Industry of India." SIR REGINALD A. MANT, K.C.I.E., C.S.I., Member of the India Council, will preside.

Tea and coffee will be served in the Library before the meeting from 4 o'clock.

WEDNESDAY, DECEMBER 5TH, at 8 p.m. (Ordinary Meeting.) SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S., "Fuel for Ships." THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., will preside.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 21ST, 1928. HIS EXCELLENCY THE SWEDISH AMBASSADOR in the Chair.

A Paper entitled "Forestry in Sweden: its Importance to and Influence on Great Britain" was read by PROFESSOR E. P. STEBBING, M.A., F.L.S., Professor of Forestry at the University of Edinburgh. The Paper and discussion will be published in the *Journal* on December 7th.

CANTOR LECTURES.

MONDAY, NOVEMBER 26TH, 1928. DR. FRANKLIN KIDD, D.Sc., Low Temperature Research Station, Cambridge, delivered the last of his course of three lectures on "Biology and Refrigeration." On the motion of Mr. Arthur R. T. Woods, General Manager of the Nelson Lines of Steamers, a vote of thanks was accorded to Dr. Kidd for his interesting and instructive course.

The lectures will be published in the *Journal* during the Christmas recess.

REPRINT OF CANTOR LECTURES.

Reprints of the following Cantor Lectures delivered during last session are now available in pamphlet form and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2 :—

"Alloy Steels: their Manufacture, Properties, and Uses," by Professor H. C. H. Carpenter, M.A., A.R.S.M., F.R.S. Price 2*s.* 6*d.*

"Scientific Foundations of the Refining of Petroleum," by A. E. Dunstan, D.Sc., F.I.C., F.C.S. Price 3*s.*

"Fatigue Phenomena, with special reference to Single Crystals," by H. J. Gough, M.B.E., D.Sc., Ph.D. Price 3*s.*

"Acoustics," by A. G. Huntley. Price 2*s.* 6*d.*

A complete list of Cantor, Howard and other lectures which have been published separately in pamphlet form and are still available can also be had on application.

DOMINIONS AND COLONIES SECTION.

Tuesday, November 27th, 1928. Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair.

A Paper entitled "Air Survey and Empire Development" was read by Colonel H. L. Crosthwait, C.I.E., R.E. (retd.). The Paper and discussion will be published in the *Journal* on December 21st.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 14th, 1928.

The Right Hon. the Earl of Crawford and Balcarres, P.C., K.T., LL.D., F.R.S., P.S.A., in the Chair.

The Chairman, in introducing the reader of the Paper, said that its subject, "English Silver and its Future," was a very comprehensive one. "English silver" no doubt meant English silver of to-day as well as English silver of bygone times, and, of course, the audience would get a view of the future from Mr. Omar Ramsden, based no doubt on his observations on present day problems. He thought, therefore, they could look forward to a paper which would deal with the prospects of applied art as well as with the powerful æsthetic aspects of that most charming craft. All present were well aware that Mr. Omar Ramsden stood in the forefront —if he was not actually the very first—among those who pursued that great and fascinating art.

The following paper was read :—

ENGLISH SILVER AND ITS FUTURE.

By Omar Ramsden, R.M.S.

It would be folly to dwell too much upon the past, for the present is ever with us, and our thoughts, most probably, are intent upon the future.

Nevertheless, some short consideration of the status and works of our ancestors is necessary to a proper understanding of present conditions and their bearing upon the days to come.

So much has been said on the question of Antique Silver, and its virtues have been so critically examined by antiquarian experts, that I should be the last to infringe upon their province Moreover, please let it be understood

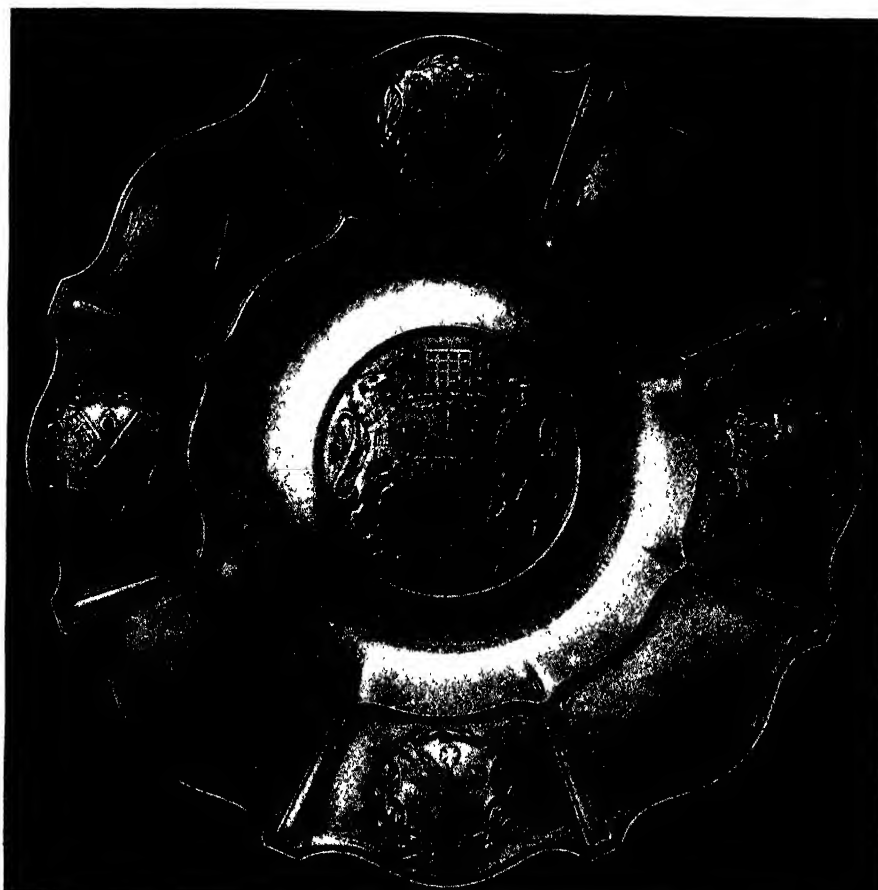


Fig. 1. Silver-Gilt Alms Dish, one of a set of four, for Westminster Abbey. Designed and made by Omar Ramsden.

that I yield to none in my admiration for the many really fine and beautiful pieces of silver which have come down to us through the ages.

On the other hand, one must have the greatest contempt for weak copies of their outward forms, copies which rarely have any of their inner virtues. As for reproductions—frankly made and sold as such—words fail me.

I think we may presume that the goldsmith and silver worker of prehistoric and tribal times, and even those of Greece and Rome, were slaves— doing their best for their masters and having scarcely any other interests beyond their work: and that *time* was of no account so long as daily progress was made. Nor would there be any competition other than that of reputation and artistic standing.

As with every rule, there would be some exceptions: and the great name of Phidias at once suggests itself.

The early tribes and nations were governed in time of war by the brawny men of sword and club; in time of peace by the craft of what we now call the witch doctor, or the pagan priesthood. Both these classes had need of the artist, and until quite modern times, historically speaking, almost all the wonderful work made was to adorn the temples of the Gods or the persons of the warrior class.

For no national life is, or ever has been, complete without the work of the artist. His art may have been fine and sincere, or florid and spurious, according to how he was treated by his masters and the demands made upon him by the every-day circumstances of his time, but living art of some kind there has always been, up to about the year 1800. In the main things have changed but little, for still are our finest efforts devoted to the decorations of Mother Church on the one hand and the adornment of our women on the other; men having assumed a sombre uniform, largely, I presume, to avoid the expense of competition in costliness, which is the result of fine feathers on the human back.

We must not assume that the lot of the artist slave was necessarily unhappy. In fact, there is considerable evidence that he was petted and spoiled and, according to his ability, bought and sold at high prices, much as is the case nowadays with the star footballer.

You will remark that I have used the term artist, for, until the advent of the industrial revolution of the 19th century, all who made fine works in silver were artists—men who produced works of art by the creative gifts of their brains and the executive power of their hands.

For the matter of that, we must own that we silver-workers indeed, all workers—are still slaves:—wage slaves to mass-production, or bondsmen to "the bubble reputation." Personally, I care not a jot who and what may be our masters, so long as we turn out well-made and beautifully-designed pieces of work, all in our respective spheres.

After the tribal workers and the slaves of classic days came the great epoch of the cloistered monk, to whom we owe those lovely, if somewhat over-elaborated, articles of Early Irish Art, wherein the northern feeling for interlacing and mysterious patterns was robbed of its ancient Viking fierceness and made suitable to adorn Holy Church. The Benedictine order, with their fine motto *Laborare est Orare*, produced most of the art work of early medieval times, and the work done by and under our great Saxon Saint Dunstan must have been wonderful, judging by the few remains of his time and the writings about them which have come down to us.

It may seem strange to us moderns that a great man like Saint Dunstan should have found time to produce art work in gold and silver. Archbishop of Canterbury, Primate of England, and what we should now call Lord Chancellor, under, or perhaps I should say, above, four Saxon Kings, he raised England, for the first time, to the status of an international power. So great was his reputation as an artist in Gold and Silver that he was chosen as the Patron Saint of Goldsmiths. That powerful Guild which guides and controls the silver production of England still have a somewhat foolish, gilt, wooden statue of him, taken from their 18th century State Barge, standing in their splendid Hall.

After the iconoclastic workings of St. Bernard, and the "degringolade" of monkish efforts, we find that the finest work done under the Plantagenet kings is produced and controlled by the Medieval Guilds. They guarded the secrets of their crafts most jealously, and by strict rules and regulations held sway for centuries. They worked equally for the Church, the aristocrat and the rich burgher, not forgetting the rich burgher's wife, who was a very fine person indeed.

They were free men, free art workers for the first time in the history of Art. Truly they made the upholding of their rules and regulations a fetish and, indeed, were slaves to their own restrictions, which in the end were to prove their undoing, but these same restrictions enabled them to keep their work fine in quality and their members honest in their dealings, until they finally became a drag upon their efforts and killed all initiative.

Then came the Renaissance, which in Art, as in most other things, knocked down the old ways and standards like so many ninepins; knocked down, it is rather sad to relate, both good and bad.

In England and, indeed, in most Northern countries, the progress of Art was somewhat slow, and the Italian and pseudo-Classic never quite uprooted our conservative attachment to old styles. For, after all, the Renaissance, as applied to craftsmanship, was but a stilted catalogue of festoons, urns, masks, fluted columns and the like; all really foreign to our national Art feeling. It was of course very unsettling, and the result was a bastard Art, more quaint than beautiful at first, which blossomed out into the elaborate silver of the reign of Charles II.

But the Renaissance finally released the artist from all trammels, and for a time he revelled in his new-found liberty. Benvenuto Cellini, artist-goldsmith, sculptor, swashbuckler, author, genius and rogue, may be taken as a type of his age. Born in 1500, he came at the apex of the rush of new ideas, or the new use of old ideas, before they had time to stiffen into the curdled mass we call the Neo-classic and the lighter, but still tiresome, thing we know as the Adam style. However charming this Adam work may be in architecture, I find its funeral urns, masks and swags wearisome in the extreme when applied to silver, and especially in the usual factory made article.

As an extreme example of what has been perpetrated let us take the ordinary pepper-pot or sugar-castor of commerce. Starting on its career as a very fine Roman funerary urn, eventually finding its way into the Vatican or some such Roman collection, it was copied by men like the Brothers Adam - still a very live thing in its way - then copied by first-class silversmiths in London. After this follows a rapid descent of copy of a copy of a copy into "a good selling line" of, let us say, 1880 to 1890. Our second-class shops are still full of it, and its sisters, its cousins and its aunts. Finally, we had the Empire Period, or late Georgian, the last with even a vestige of a soul of its own, and then the Industrial Revolution of the 19th century and the industrialisation of England.

For a time she was the "Factory of the World" in very truth, and everything, silver not excepted, was produced on commercial lines.

As a callow youth I was given a ponderous book - "The Illustrated Catalogue of the Great Exhibition of 1851." I hope most of you have never seen it for it is the most terrible and self-satisfied indictment that ever a nation produced against itself in the Court of Art.

The inevitable re-action was, however, on its way. Seen at first in the faint false dawn of the Early Gothic revival, with its somewhat foolish Strawberry Hill efforts, under the eye of Horace Walpole, to its death in the Houses of Parliament, under Pugin, it had its day and left its mark. The real dawn of a new day, a day whose sun is not yet at its zenith, took place in the world of Fine Art - in that wonderful band of painters we call the pre-Raphaelites, with its off-shoot, the sturdy effort of William Morris, whose ideas, leading to the arts and crafts movement, have profoundly affected the present-day world of applied art.

And his work goes marching on. Not only in England and Europe, but throughout the world.

He would not readily recognise many of the things of to-day as his great grand-children, but they are in a direct line of descent from his sincere if tentative efforts. Indeed, it is more than likely he would hate them.

It would take too long to follow the battledore and shuttlecock play that has been going on, seeing that, as a special subject, it would fill an evening. I would, however, just like you to realise how the New Gallery school was

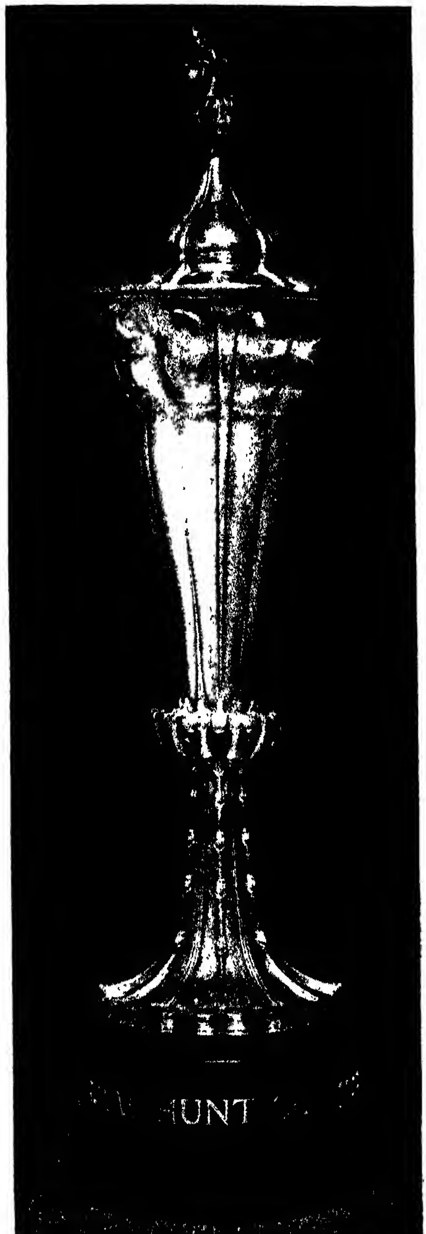


Fig. 2. The Royal Ascot Hunt Cup, 1928.
Designed and made by Omar Ramsden.

parodied by Glasgow, how Glasgow was outdone by Vienna, Vienna outshone by *L'Art Nouveau Bing*, and so on, leading to the intensely-regrettable cubism and other " isms " of our time. All these queer and awful happenings in the realm of the Applied Arts, which we so much deplore if we understand what Beauty is, will have their day also. They may serve to open the eyes of the artistic sluggard and to knock the tame stylist on the head. If so, so far, so good.

Some few examples will probably be preserved in the Chamber of Horrors like the Victorian rooms at the London Museum, but the mass will pass through the melting-pot to better things.

For Beauty is eternal and will triumph in the end.

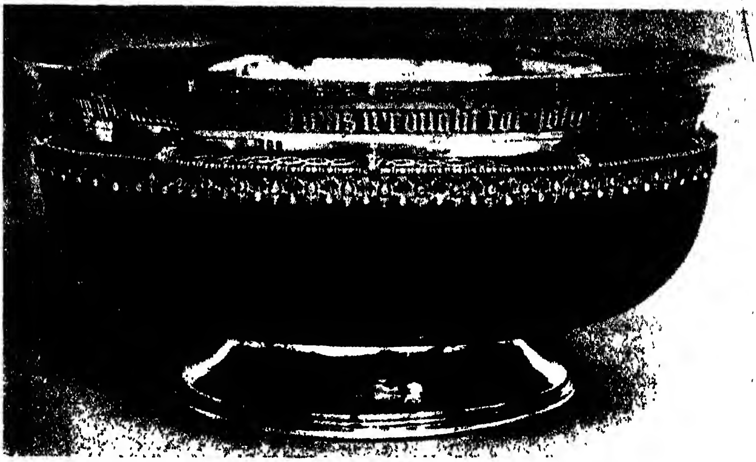


FIG. 3. Mazer, designed and made by Omar Ramsden.

I crave your indulgence for this all-too-rapid survey of past conditions, for it has been rather in the nature of a hop, skip and a jump over many things I would like to have spoken about. The works of great silversmiths like Juan Hapfe, Paul Lamarie, Storrs, and many others, have had no mention for we really have not the time for their consideration.

In fact, you may say I have said all too little about the silver-worker, but, after all, apart from a few anecdotes and the dry details of inventories and accounts, we know but little about him. It is his work that matters.

We have seen that he passed through slavery, monkery and guild-motes, into the radiant liberty of the Renaissance and the revival of wage-slavery under the Industrial Revolution. He now awaits the future.

What is the position in this present year of grace ? Every man will have his own ideas according to his outlook and personal experiences, so, having undertaken to say something about it, I can only survey it from my own studio window and the few facts picked up in considerable travel abroad.

It would appear to me that the Midlands have need of a very high protective tariff to keep out foreign silver while they take stock of their few advantages and scrap most of their old ideas. They need a breathing space badly, as far as I can see, but I wonder if they have the political initiative and power to demand this help from Government. Every other country enjoys this selfish advantage; why not England?

It enables a foreign country to charge a high price to its internal market and dump its surplus productions into ours at cut rates. A high tariff will not keep out goods of great artistic excellence, as is shown by the example of the U.S.A., where European goods of artistic merit are still imported and sold at high prices. Moreover, it can do no harm to the home buyer for, after all, silver, apart from the few household necessities, is a luxury, and no one is forced to buy.

This desire for a tariff protection by our great manufacturing towns is no new thing. When I was a boy, Sheffield cried for it because, it was said, foreigners produced work in imitation of her cutlery, stamping it with her marks.

The ground has shifted somewhat, I fear. If one wants a few really beautifully-made knives of a special shape, one must face ignorance and apathy of all kinds, and neatly-fashioned scissors on sale in places like Canterbury are found to be foreign. Moreover, agents for foreign wares have the confidence to send out pretty little lists of beautiful silver in which they practically say "Buy foreign silver, because it is best." They have no further need to hide in borrowed plumes, but are proud to come out in their own colours. Why?

Because they have discovered that applied-art ware sells on its art qualities. Unfettered by old dies, old models, and old ideas, they start on new ground. Aided by immense wealth accumulated in years when we were fighting for our lives, the neutral countries have been able to found fine schools of designers, to pay them well, and to put a new kind of factory-produced silver on the world market, about which I shall have more to say later on.

They have one other advantage, also, in the fact that the average British buyer likes to spend his money on foreigners, in the same way as he likes to hear foreign opera or dance to foreign jazz tunes.

As a nation we are inclined to believe that any art product, to be really fine, must have made a sea-crossing, and this in spite of the enormous prices paid, in the auction room, for the work of our English forefathers.

As a nation we have spent untold millions on a school of Art system which tends to bring forth more or less efficient producers of Art wares, but which seems to have had very little effect in educating the buying public to the proper appreciation of English art, either fine or applied.

Things are not so bad as they were a quarter of a century ago, it is true, but there is room for great improvement in public taste. During this summer I

was much struck by the large number of fine shops selling silver in the cities of Scandinavia. Corner sites which in England would be occupied by prblic houses or banks, have really wonderful displays of silverwork; some cheap in quality and slight of merit; some the work of artist-craftsmen, but all attractive in design.

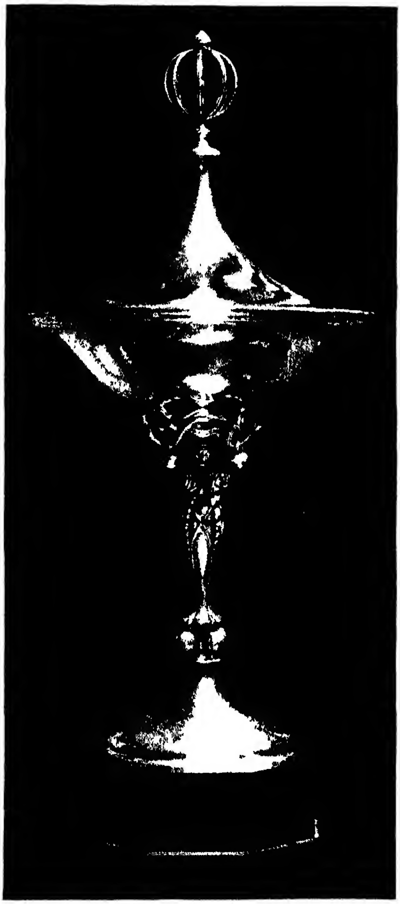


FIG. 4. Golf Challenge Cup, intended as an effort to get away from historic styles and conventional treatment. Designed and made by Omar Ramsden.

It is rather a reflection on our education to find that a small country of less than five millions total population - much less than that of London—is supporting some seven or eight well-known artists-in-silver, as well as large factories

for the cheaper wares. I am forced to the conclusion that, even allowing for a large export trade, she must use more and better silver per head than we do; moreover, that she knows and values Art and artist's work—a thing our manufacturers have still to learn.

One more remark, and I have done with the present and will pass on to the future. I refer to the curious way our English Committees of taste often select designs for important presentations from a competition of several invited firms.

I have been informed, over and over again, that, after a cursory glance at the drawings, the question invariably asked is: "What are the weights of gold or silver suggested by the would-be makers?" and that hands always go up for the heaviest, irrespective of any artistic qualities the designs may happen to possess.

Important firms, I am told, lend themselves to this curious form of "nugget giving" competition under the mistaken idea that it is a good advertisement to get the job, and that the public neither know a good design when they see it, or care for anything but weight of metal.

They do not know that some of the very finest pieces of silver ever made in olden times are of the thinnest gauge it is possible to employ, and that art-qualities, not weight, are the all-important points in any article that is to survive the test and judgment of time, and that design is most important and must be wedded to perfect workmanship to achieve a proper and pleasing result.

To attempt to forecast the future is a thankless, uncertain and dangerous undertaking. I can only say what I, as a student of my art and craft for some forty years, believe to be the trend of things.

In northern countries we can take good workmanship for granted, in the main; therefore it all resolves itself into a question of design. Personally I am inclined to believe there will be two quite separate and un-related bands of silver workers in the future—a small band of artist-craftsmen who will gradually absorb all the important and unique work, such as church ornaments, presentation pieces for important occasions and for ceremonial purposes, and a larger—much larger—group who will work for factory production.

The latter will copy from the former, for, of course, the present dry-as-dust stuff will not last much longer. Good design in beautiful forms will hold the day both in studio and factory. One will act upon the other and in the end we shall have fine good work. Good factory-produced work for the masses and good, unique work for the connoisseur.

In England we have not yet attempted much on these lines, being full of faith in our old dies and models, but it will be forced upon us in time. When in Paris a few years ago I suddenly came upon a splendidly-appointed shop, full of beautiful silver and I thought a new thing had happened. I thought that here there was an artist-in-silver who had talent to produce and, what

is tremendously important, the capital to put his work on sale in a fine and attractive shop. But, when in course of time, I saw exactly the same things, in similar shops, in half-a-dozen European Capitals and heard of them in the cities of America, I realised that a new thing had indeed happened, but not what I had imagined.

FIG. 5. Silver Jug. Designed and made by C. Muller, of Halle. A typical German effort to get away from the ordinary type of article.

I suppose one must say it is the relentless exploitation of an artist's name and work, in the world market, by almost unlimited capital. Truly it is a sign of the times and an indication of what must happen in the future of factory-produced applied Art. May we have the brains to copy its methods, but let us be true to ourselves and keep clear of its designs! Let us go one better, both in art and commerce; for we can. There is room at the top for all.

The recognition and appreciation of Beauty is not an easy matter for moderns who are untrained in art, because during the past hundred years or more our

thoughts have been turned in other directions. And this is not the time or place to discuss the Industrial Revolution of the last century, which is the cause of this; for mass production and cheapness have doubtless come to stay. Nevertheless, Art, fine or applied, is still an important factor in our lives; much more so than is realised by those millions who know little and care less about it. They are much to be pitied and should be helped to a better understanding of its delightful qualities in every possible way.

It behoves us to take stock of the situation before we, as a nation, take a back place. Much is being done in this direction by other European nations, who realise that Art is not only delightful but can be a real business asset. It is high time that ordinary people, for their own good and for the well being of England, should cease to regard Art as an exotic plaything of the rich. It really is a national necessity; we must begin to think!

Short cuts to effect, like the camera, the gramophone and the process colour-reproduction, have almost killed the faculty for honest mental effort, and lead us to expect all our joys to be neatly made by machine and served up in highly coloured cartons.

We must first of all endeavour to upset two very dangerous opinions which are in vogue among the mass of English people. First, the view so often heard, in words something like this: "I know nothing about Art, but I know what I like when I see it, and that's that"; secondly, the opinion, generally expressed with an air of finality, that, "We are only sure of Beauty in the presence of antiques." One might add, in passing, that juicy colour and pretty-pretty ornament are snares to catch the unwary, but sometimes have a little use if they start interest in an otherwise "Art-blank" mind.

Up to about 1800 it seemed difficult for men to produce really ugly work. It now seems the reverse. Grotesques there were in plenty; coarseness even, but always a touch of art-spirit. Yet there is no excuse, except mental laziness, for the present widespread non-appreciation of art by the lay mind.

A devoted and ever-increasing band of art-workers, who live and work in spheres over and above the domain of mass production, are placing before the eyes of those who can see, things of real beauty, and I venture to think that their works are equal to and often better than the much-prized antique. Different, of course, for we live in very different times, but splendid in their way; all they need is proper appreciation, their meed of praise and patronage.

Much of their work in the less costly materials is within the reach of the most modest purse, and it is extremely interesting to see the effect of even one object of beauty in some household hitherto lacking in that respect. I feel it has not yet become known that the worship of the antique is one of the great drawbacks to the modern craftsman. Cleverly worked up by interested parties, it has become a vortex into which is drawn the interest and money of just that class of well-educated and well-to-do people who would otherwise be his best patrons.

Unless I am mistaken, museums were founded for, and should be the best friends of the craftsman and designer as worlds of inspiration to fresh efforts but they seem to have become, at least in London, one of the principal aids of the antique dealer and the faker. It is even suggested, if one may judge by correspondence in *The Times*, that we should have examples of the faker's work placed side by side with the originals, in order, I suppose, to show how clever he has become in his artfulness. It all savours to me of collecting mania, of the idea that our museums should be complete collections of good and bad, instead of consisting of only the very finest objects of each class of Art-work. Moreover, we should have, as other nations all seem to have, a museum of all modern work. Work of the living as well as the dead should be on view.

It is true that many beautiful things are costly, but it should be realised that beauty is not the prerogative of wealth and lends her charm to the work of the humble village potter no less than to that of the most lordly state-aided porcelain factory.

It is also true that real beauty is seldom present except in due proportion to the amount of human thought and work that has gone to the making of a thing.

Exactly how the study of beauty should be approached is somewhat difficult to explain to the uninitiated, but a beginning may be made by an attempt to see what the creator of the work was aiming at when he evolved his design, what was passing through his mind, what were his particular difficulties.

Much can be achieved by representatives of our old families who have been brought up in an art-atmosphere-- and there still are many in spite of modern conditions—by teaching the new monied classes, who are often eager to learn, how to approach the appreciation of Art.

It goes without saying that any work of art must be suitable for its position and purpose, so we will take that, the first principle, for granted. All the statues and paintings of ancient and medieval times, as well as jewellery and pottery, were created for a given position or person, and therefore each of them have certain qualities which are denied the easel picture or the modern mass-produced article.

The next step is to consider if the main lines and proportions are good and pleasing, and if these same essential parts grow out of the construction. At first all this may seem somewhat complicated, but it soon becomes a habit of mind—points being observed in a single glance. Most of us will pause to admire a May tree in full blossom and think how sweet it all is. How many see that tree not only as a white cloud of lovely blossom, but also as a finely-proportioned mass of green leafage, a massing of light and shade due to the way the branches and twigs distribute the bloom ; the whole borne upwards on a twisted and fluted stem which has known the winter gale. In fact the same tree in winter with its wonderful anatomy, trunk, branch and radiating twigs, is almost as beautiful as when in bloom, seen by the seeing eye.

I admit that the wonders of modern progress have so filled our time that, in our hurried careers from one point to another at so many miles an hour, we have but little left for such pleasant studies. We *may* just take in the large and cubistical poster on the wayside, for it is designed to hit one in the eye, but we know not what we miss in our oblivion of art and nature.

It may be true, as some writers would have us believe, that we are groping out to the beginnings of a new style, and therefore must go back to the crude ideas of prehistoric man. I will not say "cave man," because some of the finest examples of pure line drawing are the work of what we call "cave man,"

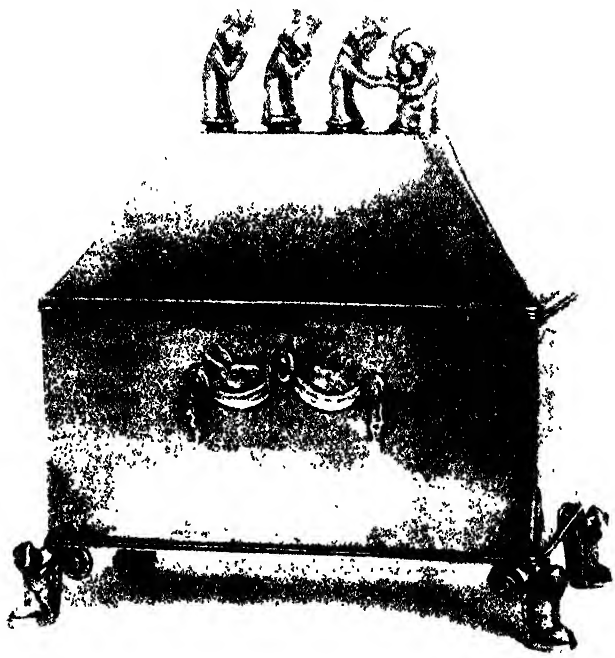


FIG. 6. Silver Casket, designed and made by Jacob Ängman, Stockholm. Illustrating the present-day Swedish effort towards simple forms and restrained ornament.

and the work of the savages of the South Seas—chip carving, mat weaving and the like—is really extremely beautiful, considering the circumstances under which it is made, and used.

Above all, let us beware of judging a work by its price. Let us not think a picture or a bowl is the more beautiful because clever dealers have forced its auction-room value up to colossal sums. Beauty is a thing apart from price; which depends upon rarity and artificial forcing.

A set of the "Holy Grail" tapestries were recently sold at auction for some eight hundred pounds, well under one hundred a piece—this one of the loveliest creations of modern times. Burne-Jones does not happen to be in fashion. One day it will sell for fifty or a hundred times that amount. But its delicate beauty will be the same as ever, no matter its price at the moment.

A thing of beauty must be well made in addition to being well designed. On this point we can, in the long run, trust the latent feeling for good work which is native to our northern peoples. It was doubtless this Nordic spirit of beauty which led William Morris to revolt against his surroundings and to create his "earthly paradise," not only of poems, but of visible forms of applied art, and to initiate the present-day ever-growing productions of art work in which real beauty is present in ever-increasing volume.

There is, indeed, a danger of this fine movement being side-tracked by the present vogue for ugliness as a cult, but I have faith in the mental balance of the main body of people who will see it is, after all, but an advertising stunt to catch the eye of a world beginning to weary of exotic post-war conditions.

We may never recapture the exquisite, wonderful pleasures which are our birthright and which were enjoyed by all in earlier times, but we must make the effort.

As an extreme example of these mental pleasures of old, of which we have a written record, one may cite the story of François Villon, a poet, of the common people, who relates how, outlawed for some of his many peccadillos, starving, in rags, and with the watch upon his track, he was fain to pause in his flight to admire some piece of Gothic architecture, newly wrought in Paris.

At the other end of the medieval social scale we have great men like Louis XI of France, our Edward IV, and even Henry VIII, all busy with cares of State and family troubles, but all keenly interested in the art of their craftsmen. We have only to add our admiration for the country houses of England and the Burghers' mansions of Germany and Europe generally to see how innate to all, high, low and middle classes, was this great appreciation of beauty—beauty applied to the objects of ordinary use—to realise how full of pleasure their lives must have been.

I recently saw in the old Castle of Shokloster, in the middle of Sweden, a collection of some 2,000 pieces of medieval weapons, not one of which but was a work of art. So even the instruments of murder were produced by artists.

Sic transit gloria mundi. But we must recapture these lost glories of the world if we are to keep our place amongst the great nations many of which are now making fine efforts and with remarkable success.

We Britishers are said to be slow in the uptake, to use an Americanism, but it is usual for us to muddle through somehow to a successful issue. We are plodding along a somewhat dreary road at present and victory is not yet in sight.

But I have every confidence we shall win through in art matters eventually, as we have done in other walks of life.

Let us pull together, artist, designer, master and man, sinking small, mean differences for the common-weal and we shall have a splendid chance of regaining our natural position as leaders in the world of applied Art.

DISCUSSION.

THE CHAIRMAN said that the reader of the paper in giving a survey of the art in which he was distinguished had also tendered a measure of advice and of philosophy upon the arts in general in Britain. He was sure they were all very grateful to him, not merely as a craftsman, but as a philosopher, not merely as an exponent of one particular art, but as an observer upon the wider uses which art, as art, imposed upon them. He did not dislike the controversial attitude which in one or two particulars Mr. Omar Ramsden rather provocatively assumed indeed in a way he liked him all the better for it. He liked his spirited attack upon the worship of the antique He assured Mr Omar Ramsden that, although they might over-worship the antique, in times past it had been by no means inconsistent with the most notable productions of the actual living. Mr. X—— was a crank on antiques more than any other living contemporary. Mr Y—— was so great an admirer of antiques that he complained that he was not able to find enough to satisfy his desires, and he was therefore obliged to purchase bronze sculpture by Mr. Z——. Nowadays, a high percentage of antiques were forgeries, and if that fact could be impressed upon the buyers they would turn in despair to Mr. Omar Ramsden.

While he watched the wonderful series of pictures that had been shown, two facts had been impressed upon his mind Firstly, so frank was the lecturer towards himself and history that he (the Chairman) would like to have seen fifty pictures of the author's own work with a narration beginning with the weaknesses as he saw them now by his experience and knowledge, and showing where progress was marked or otherwise. Secondly, in spite of the wholesale idea that tradition was a dangerous thing, it was a very difficult thing to escape from. Even if Mr. Ramsden were told to make a bell for the Royal Society of Arts, with a diameter of base of 2½ inches and a complete height of 5½ inches, he would find it very difficult to escape from the bell on the Chairman's desk. He had admitted already that he had been unable to escape from the traditional form of the mace, and they all knew that a teapot had very unescapable qualities.

He (the Chairman) believed they should not be afraid of tradition It must be remembered that tradition was something which had survived a great many centuries and had an anchorage in the past; and it at least gave one a fixed point from which to start and towards which to recede, as well as a standard of comparison and a test of merit, at any rate of craftsmanship, if not of artistic values. Therefore, every craftsman to-day could profit by studying those gold vases of 3,500 B.C. which were dug up at Ur last summer by Mr. Leonard Woolley, which were notable for their complete absence of decoration—not one symbol or sign, nothing except form. Form was really the essential, and, as time went on, Mr. Ramsden was coming more and more to Form as the great basis of his art. The last picture he exhibited, the alms dish, was the finest, and yet it was the most simplified, of all Mr. Ramsden's work. The fact was that silver was a material that lent itself

more than any other to simplification. It was true that the bell by Reid Dick, which was among the earlier pictures shown, might have been in bronze. There was no reason why it should be in a precious metal. One of the Scandinavian works, and also an English one, struck him as adapting a design inherent in embroidery, which, for silver, seemed to him entirely wrong. He liked silver to be silver—to have the qualities of silver. There was a certain heaviness about silver. He had occasion to be on a Committee which presented a piece of silver to a very distinguished person a few months ago. It was a good heavy piece of silver, and the recipient said when he received the very handsome gift: "I like this so much that I should like to drop it on the ground and hear the noise it makes!" That was silver! They wanted something that was worth carrying away. Silver was not only a noble, but it was a very precious material, and there should be plenty of it—something thick, heavy and rich. He hated all the tiresome depreciation of British virtue that was so frequently heard. The older he became the more he admired the virtues and achievements of his fellow countrymen. It was quite true that to-day the artists of this country were not producing, as Mr. Ramsden stated in at least three different points in his paper, with the same vigour and vivacity as some of their Continental competitors, but it was possible to take comfort in the fact that in the past on more than one occasion and in more than one art they had led the world. In the Thirteenth Century there was produced in this country the Opus Anglicanum, an embroidery which was fully acknowledged by the greatest Popes of that period to excel all others. The finest embroidery of that period was English. If we did not excel all others we nearly rivalled all others in Church embroidery art. In an early stage of his paper Mr. Ramsden referred to one work done by the Irish. Technically, there was a masterly skill of handling, and in Dublin there was work among the finest of its kind in the world. Ireland had had distinguished makers in the past, and he hoped they would recur in the future. He supposed the Jacobean silver produced in this country was greater than the German silver of the same period. With reference to what Mr. Ramsden referred to as the Victorian Age, it had produced the pre-Raphaelites, whom he (the Chairman) admired, and it had produced William Morris, whom Mr. Ramsden adored. It started, it was true, mass production. They were always frightened of mass production. Why should they be, if the model was good? William Morris's books were good things, but William Morris's "Chaucer" would be no less beautiful if ten thousand copies had been printed instead of two hundred. He (the Chairman) would love to see a beautiful postage stamp reproduced by mass production, and tea-spoons and other things. They did know, however, that mass production was a very simple and convenient method of multiplying ugly things, and if he could share Mr. Ramsden's optimism on the subject and believe that breathing space would do them good, he might actually prefer the "nugget." He thought, however, that the breathing space was going to cause them to breathe a little too stertorously.

One delightful point in Mr. Ramsden's lecture was his question Why not England? Why not, indeed! He hated the depreciation of themselves, and when he heard they were only producing bad work, and that in France, Germany, Italy or Spain they were producing good work, he would remind them that when they went to those countries they would see things just as ugly as in this country, and, in some places, ten thousand times more ugly. He thought they would win through by effort if everybody interested, not only in the arts, but in the greatness and the dignity of our country, would do everything possible to bring it about.

Sir Henry Miers, F.R.S., explained that he attended the meeting with no special knowledge of the subject of the lecture, but he desired to say how pleased he had been in following it. For many years, as an officer of the University of London, he had the pleasure of contemplating the mace of the University, but from what Mr. Ramsden had said that night he must no longer admire it. The great interest of the lecture to him was that it was the first example he had heard of an artist criticising himself and giving examples of his own works, and so to some extent revealing the workings of the artist's mind. He could conceive of nothing more interesting. He did wish, however, that Mr. Ramsden could have told them which, out of all the examples of his work, he considered the best. In regard to his statement concerning the museums of the country, he (Sir Henry) fully agreed with what he said about the absence of modern work. He would like to know how proper representation of work was to be achieved not only of original examples but of facsimiles. From what Mr. Ramsden had said, he believed he condemned all facsimiles and reproductions. Mr. Ramsden had shown by his work what a leading position he occupied in the working of precious metals, and he would like to say how much he had been moved by the very interesting lecture, and how much Mr. Ramsden had brought before them the value and importance of his work to the country at large.

Mr. G. R. Hughes (Goldsmiths' Company), said that on looking round he saw so many fellow members of the Goldsmiths' Company (including the last speaker) that the task of trying to say what the Company was doing in that connection was rather an embarrassing one. The policy of the Company could be summed up in one word—co-operation. It was trying to join forces with the Schools of Art, the individual craftsmen, the factories, and the retail silversmiths (which together formed the industry) in bringing prominently before the public the best modern silverwork that could be produced. That policy was worked out in various ways. First came the Company's collection of modern work. Mr. Ramsden spoke of the need for a museum of contemporary art. That was precisely what the Company was trying to form gradually in contemporary silverwork. Possibly one reason why such a museum had never been started in this country was the extreme difficulty of selection. They had experienced this in the case of silverwork. The selection rested with the Company's judges, of whom he saw at least three there that night. In the choice of the things they selected, they were open to criticism on every side. If they bought a museum piece from an individual craftsman it was said that it was not benefiting the trade; if they bought a mass-produced article of good form and design it was said that they were not helping the silversmiths' craft. The truth seemed to be, as Mr. Ramsden said, that there was scope for both individual craftsmanship and mass production.

On the whole, the collection had so far vindicated itself. It had been lent, sometimes at the request of a trade firm, sometimes of an art gallery, to Birmingham, Sheffield, Bath, Manchester, Darlington and at present part of it was at Oxford. Here it had had the severest possible test of standing side by side with four centuries of antique plate, and generally the criticism had been not unfavourable. One critic, it was true, in a paper, said that it represented the worst Nouveau Art of twenty-five years ago, which only showed that he had neither studied the Company's collection nor the history of the silversmiths' craft. So far all he had said dealt mainly with the question of bringing good work to the notice of the public and, incidentally, good designers to the notice of the trade.

Next came the difficulty of getting some of the best art students to go into the industry. They saw a wider field and better prospects in poster design and illustration work. That difficulty was being met to a certain extent by the granting of scholarships, and was, of course, dependent on improving trade. Two boys with travelling scholarships were abroad at the moment. The first had been four months in a Paris workshop and was now in Helsingfors; the second was attached to the Technical School in Munich under the care of Herr Lehr, of the National Museum, who had charge of the department of contemporary applied art which had been formed there. It was interesting that such a museum (as advocated by Mr. Ramsden) should already exist in Munich, and that a student in the silver trade should be in a position to see at first hand how this collection was being made.

Lastly, lectures and discussions were held from time to time at Goldsmiths' Hall, to which people who were concerned in the industry, from many different aspects, came. Not long ago Mr Ramsden was the principal speaker, and that week Mr. Watts was giving two lectures on the Oxford Plate. A great many people came because these meetings gave them an opportunity of talking over what was happening. The object of the Company was to introduce artists to manufacturers, and salesmen to craftsmen, so that they might all go away with a better understanding of one another's point of view.

MR. A D. BISHOP (Assay Office) said he came there that evening to listen to a very interesting paper, and in the hope that he would find the lecturer a true optimist. He had not been disappointed. Mr. Ramsden and himself had known each other for a number of years. He was with him as an optimist, but he thought that they would all agree that if the silver trade was to be placed in the position in which they all desired to see it, different methods would have to be adopted. In order to get a true perspective of the situation, let them consider some of the old masters in the trade. If they were fair they had to admire their work—the works that were included in the national collections, the private collections and in the wonderful collection at Oxford. He did not ask the meeting to look at them as antiques. Let them be looked at just for their worth. He thought they would agree that their works were very beautiful and well executed. When they looked at modern art, did the question ever enter their minds: "What would these old masters think of some of the factory-produced articles we see in the shops to-day?"

He would select for comparison Paul Lamarie. He was a man of note in his time. He rose to the position of Prime Warden of the Guild of Goldsmiths. He worked at the bench. Quite recently a man showed him a large collection of Paul Lamarie's works, and he made the remarkable statement: "Paul Lamarie must have had an enormous factory," and when he (the speaker) told him that Paul Lamarie worked in his shop with two assistants he was somewhat staggered. He thought that English silversmiths were, perhaps, the most generous workers in the world, because from time to time they had taken into their ranks foreigners and other people, and he thought that in most cases it had been found to be of advantage to the silversmiths. In recent years there had grown up a body who had attached themselves to the trade. They were described as artist-craftsmen, and to give them their full credit they had done some very wonderful and very beautiful work. But outside of these artist-craftsmen a number of other people had come forward, and these called themselves artist-craftsmen, but he thought that the less said about them the better, because their work was not helpful and it led nowhere.

He was reminded that when talking to these people they all seemed to have the idea that they should receive full value for their efforts. They seemed to forget

the fact that if a man was successful he was not only a good designer and a good craftsman, but one who could dispose of his goods as well. He hoped that they would bear that fact in mind, because there were a good many people in the world to-day, not only in the silver trade, but in other trades as well, who produced an article and said in effect: "I made it; now go and sell it." With regard to the question of a remedy for the present state of affairs, he thought things were bad, but the education of the British public was what he had always advocated. He could imagine some people saying "Good luck to you." He was fully aware of the fact that in England there was a large number of people who, when they had £10 to spend asked, "How large a cup can I get for the money?" But he was not discouraged by that. All of them could remember that years ago when they went down Bond Street they saw in the shop windows articles of jewellery of enormous size, such as huge cameo brooches, and large drop ear-rings. Could they imagine anyone having a collection of these to-day asking anyone to go and see them? No; on the contrary, he wrapped them carefully in a parcel and the next time he visited the jewellers he left them there and they started on their journey to the melting pot! In a comparatively short time a revolution had been brought about in the jewellery trade by the goldsmiths; and surely the silversmiths could do likewise. Therefore, he thought the sole remedy for the present state of affairs was the education of the British public—in other words, propaganda.

Mr. Omar Ramsden, in reply, remarked that most of the speakers had stated better than he had done what he meant to convey to the meeting. He thought the Chairman should really have delivered the lecture. So far as the Chairman's remarks went, there was very little to answer. He knew that the appreciation of antiques was a very old thing, in fact, the Renaissance was due to renewed appreciation of them; but there were many hundreds and thousands of imitations and fakes to-day. The other day he was giving a lecture at Oxford, and he spent a couple of hours at the interesting exhibition there. One thing struck him, and that was that, although it was a fine collection of exhibits and there was a full attendance of people looking at them, yet one could see a finer collection in South Kensington, for nothing, at any time—only it had not got a Press. This showed the value of a Press notice. He did not want to belittle anything at Oxford, but if one took away ten or a dozen of the finest pieces, there was nothing very remarkable about what remained. There were finer chalices in South Kensington Museum than he could find at Oxford. He was of opinion that we were inclined to "over-oxidise" our silver in these days, but it was easily removed if only the owner would give it a good brushing with powder or other material. With regard to what Mr. Bishop had said, there had been an enormous advance in the last 25 years. The main point he wished to make was not so much to point out the advance they had made, but to suggest that they might make a very much greater advance, and he hoped by showing what had been done abroad to spur them on to do a little better in England. As Lord Crawford had pointed out, there had been times when England had led the world, and at the beginning of the William Morris movement there was a chance that she would lead again, but the arts and craft movement as originated by William Morris, with the exception of one or two West End firms who had made a business of it, had been ignored; its potential influence had been overlooked and side-tracked. He believed the position could be regained, and he thought they should make an effort in that direction. In regard to the work of artist-craftsmen in England, this was far ahead of anything else being done in the

world. The ordinary run of manufactured stuff in this country was not up to the ordinary run of manufactured stuff abroad, but it was not so with regard to the work of the artist-craftsmen.

The proceedings concluded with a most cordial vote of thanks to Mr. Omar Ramsden, proposed from the Chair.

MR. W. AUGUSTUS STEWARD writes: It is always necessary to look back as well as forward, as Mr. Ramsden has done, so far as what we generally term style or fashion is concerned; but we must also look back for the principles and the traditions underlying the production of the types evolved, the execution of the styles which have persisted.

What we are worrying about just now is the weakness in design rather more than the quality of workmanship. Design is often moribund for want of imagination and lack of encouragement, because patrons demand copies of old things from Georgian to Plantaganet; and because the designer has been more or less looked upon as the cheap factor in production—the person to put together in a somewhat new way such old models as may exist in a more or less well-equipped workshop.

Imagination is hardly demanded from one who is only required to play a game of patience with provided units. It is hardly needed, indeed, cannot be expected while weight and fashion rule.

But the failing is not entirely due to the lack of suppressed imagination or the demands of the modern economic situation. There is a factor which must be realised and appreciated if the economic situation were so revised as to give us free play. It is the understanding of the material in which the design has to be made. It is that practical understanding which has given Mr. Ramsden his position. It is the lack of that understanding which makes modern silver, no matter how produced, whether by hand or mechanical means, often so spiritless and unappealing.

Designers made in Art Schools have had no small part in retarding the Craft. Not until our silver designers have learned how objects can be made, what limitations are imposed and what possibilities lie in the metal—in a word, not until they can think out design in an understood medium—can we generally hope for a successful wedding of Art to Industry.

As for the past, were there castes of designers, smiths, chasers, etc., in the days of Abraham? I think not. Those remarkable examples of goldsmithing produced in Ur of the Chaldees were, in my opinion, thought out and executed by one man. Here is a point of great technical interest. In those far away days the workers in precious metals had already thought out and laid the broad foundations of the principles for the sound construction of forms to be made in precious metals. Forms and styles have varied, but the principles of construction have remained constant for over 6,000 years, and those ancient principles remained unchallenged until the mechanization of industry made possible mass production. We have to face that modern factor. We have also to fight the snare of novelty.

In the past we see that beautiful forms evolved from the simple objects which man, in his growing intelligence, produced for his use. Have we exhausted our fund of sane imagination or do our eyes fail us in the outlook? Surely we have something new to offer!

It is true that the possibilities of our Craft have been greatly exploited by craftsmen who learned how to fulfil all the requirements of a piece of personal, domestic

or ceremonial silver by the variation of standard forms, so that the numerous forms evolved have apparently left little for the creative spirit of us moderns.

But there is yet a great field in which we may work out variations indicating that we are not lacking in conception or knowledge of where to place rightly a pleasing or amusing fancy. Mr. Ramsden has demonstrated that.

In looking forward let us also think of the present in terms of machine production, for while our art may stand by the hammer our daily bread is, so to speak, ensured by the machine. The stamp and the spinning lathe are now largely used in the production of dozens of cups, all of the same shape and weight, also tea sets, and so on, to supply the general public at home and overseas.

We must look at the new factors in production without fear, and must not permit them to enslave us. There is no reason why the design should not be vastly better. It would be so if properly trained men were employed and manufacturers would not be so easily led away by the fetish of cheapness or the snare of novelty. That we have splendid exponents of silvercraft is beyond doubt. Several German manufacturers and craftsmen in silver recently said: "We have nothing to teach you (the English) in making silverware." They might have added: "your design for domestic plate—where it is not a copy of old patterns—and your gift or ceremonial plate would be a good deal better if thought had been put into it and cultured imagination given its opportunity." Given the patrons, we can, and do, produce things of beauty and a joy for ever.

I have been comparing the delightful old plate at Oxford with the examples of modern English work shown beside them and I came away with the feeling that we were not quite so badly off as some might think, thanks in no small measure to the inspiration of William Morris and the sincerity of his followers. That we have so many excellent smiths and some good practical designers is due to the foundation by the old Technical Education Board, of the L.C.C. School of Silversmithing and Allied Crafts. But for that, plateworking, the raising and the shaping of an object with the hammer, would, by this time, have become almost a lost art.

It has been saved, and Mr. Ramsden's paper is but another appeal that a real effort shall be made by all concerned to raise silversmithing and its allied crafts to the enviable position maintained ere intense specialisation and other economic considerations began to undermine them.

For the present situation the manufacturers blame the distributor and the distributor blames the want of imagination on the part of the public. All are more or less to blame. Meanwhile clever craftsmen and designers have been easily attracted away to other callings where they can express themselves.

OBITUARY.

Thomas Brough, J.P.—Mr. Thomas Brough, who died, after an operation, at Halstead, on November 13th, at the age of 52, was born at Macclesfield and received his early training at the Technical School of that town. He at once found his *métier* in designing, and after spending some time in the employment of Messrs. Grouts, textile manufacturers, of Great Yarmouth, he was subsequently engaged as designer by Messrs. Courtaulds, Ltd., in whose service he remained for twenty-nine years until the time of his death, when he occupied the position of chief designer. Mr. Brough was recognised as one of the leading authorities in the application of artificial silk to the textile industry and contributed a number of articles on the subject to *The Times* and the *Manchester Guardian*. He also read

a Paper before the Society in 1926 on "Artificial Silk," for which he was awarded the Society's silver medal.

Mr. Brough was a man of various interests and identified himself with a number of local activities. He was formerly President of the Halstead branch of the Workers' Educational Association, and at the time of his death was one of its vice-presidents. He also held a high position in the Masonic world, being a Past Provincial Grand Steward and Master of the Joshua Nunn Lodge. He had been a Fellow of the Royal Society of Arts since 1926.

NOTES ON BOOKS

MODERN ROADMAKING, WITH SPECIAL REFERENCE TO MATERIALS AND PLANT. By Harold Bradley and C. C. Hancock, with Foreword by Sir Henry P. Maybury and Introduction by Edward Willis. London: The "Contractors' Record," Ltd. Price 15s. net.

In the making of any book with a serious purpose there are two prime factors: firstly, a clear conception of the task to be accomplished, secondly, the degree of skill with which it is brought to a successful conclusion.

The authors, in the preface to this work, have most clearly visualised the task before them, and it may be said at once that the manner in which they have accomplished this is convincing and satisfactory, and has resulted in the production of a work which will fulfil its purpose as teacher and remembrancer, but best of all as a stimulus to thought, and to further progress and research.

There could not be a more opportune time for the publication of a treatise designed to set out in a compact and convenient form what may be described as the post-war conditions of road construction. The creation of the Road Fund, with its large annual revenues, and of the road policy based thereon, under the far-seeing guidance of Sir Henry Maybury, has produced an entirely new standard of highways work and efficiency measured in terms of highways traffic and user, and this has been in being a sufficient length of time to establish certain methods, and the merit of certain new principles.

The treatment followed by the authors is singularly appropriate and modern, and they have struck quite properly a nice balance between what may be termed professional practice and commercial conditions, recognising, as is indeed the case, that much of the evolution and change has arisen from special methods, special machinery and processes, which are the outcome of intensive industrial research and competition.

For the purpose in view, therefore, they have quite rightly ignored the historical side of British roads, most of which has already been adequately recorded by past writers. For equally satisfactory reasons the scheme of the book excludes such subjects as the planning and design of roads, etc., which would require a separate work.

The subject of construction, to which the authors have largely confined themselves, is by itself a wide and fruitful field of investigation, and the record and data compiled by them represent what may be termed good standard modern practice.

Their manner of putting before the reader the difficult question of surface construction is perfectly sound, and they wisely indicate future possibilities by referring to processes yet under trial and materials still in their infancy. For the first time a work has been issued which acts as a comprehensive guide on the inter-related

factors which go to make up successful road construction, and the authors have been at great pains to explain and set out in clear and unmistakable form the value to be placed upon such vital things as machinery, foundations, drainage, materials, etc. Certainly good construction has been their motto, and portions of the book can be read and re-read with fresh interest.

In quoting fully from actual specifications, whether of official or commercial origin, they not only furnish a standard and a clear insight into a difficult branch of this work, but provide an interesting basis of comparison.

Scant justice has been done to the bibliography of this interesting branch of engineering. Perhaps in the next edition this could be usefully extended to include many works which deserve to be better known and recorded.

The book as a whole, though there are occasional minor faults, can be most warmly commended. It helps to fill a gap which exists in English road literature, and will stand comparison with the many excellent American treatises. Its production has been most carefully thought out, and a word of commendation is due to the excellence of the illustrations. The use of colour for illustrating the sections of asphalt surfaces is most effective.

R.G.W.C.

BELLS THROUGH THE AGES. By J. R. Nichols. London: Chapman & Hall. 21s.

I to the Church the living call,
And to the grave do summon all.

Thus runs the inscription on a Brighton church bell, and it would serve to remind us of what we are probably in no danger of forgetting, that for centuries the art of campanology, like other arts, was mainly practised in the service of religion.

But the original, the ultimate, the intrinsic virtues of this art are æsthetic, and they appeal to, and stir, our contemplative imagination. "'Tis at this hour,' writes Vernon Lee, of sunset, "to the sound of bells, that the genius loci of old cities gathers itself up and overcomes one's heart." The sound of bells in an old city, or in a mountain valley, can convey to us almost more forcibly than anything else a sense of that "je ne sais quoi" which Anatole France said was "ce que la vie a de meilleur," adding, "et qui n'est point en elle."

The history and technique of campanology are interestingly described by Mr. Nichols for the general reader. We find that, as usual, the conceptions of our own time are neither more subtle nor more colossal than those of time past. Not in England, nor even in America, is there a bell to compare in size with the gigantic bell of the Kremlin, which was cast in 1734 and weighs more than 160 tons. However, three years after casting, the belfry caught fire, and since then the Tsar Kolokol has been nothing more than a curiosity. Our own biggest bell is "Great Paul," in St. Paul's Cathedral, which weighs nearly 17 tons and cost about £3,000. It is the largest *ringable* bell in the world.

Mr. Nichols has a good deal to say about the English bell founding industry, since English bells are exported, not only to America, but to the Low Countries, where the arts of making and ringing bells had already reached a high degree of perfection several centuries ago. Our first known professional bell-founder, Roger de Ropeforde of Paignton, lived in the second part of the thirteenth century, while at Caversfield, Oxfordshire, is a bell that is supposed to date from the twelfth century.

In these early times bells were the objects of much superstitious feeling. They were solemnly baptised and christened, and in the popular belief had power to put

to flight evil spirits. Horace Walpole had, according to himself, a bell made by Benvenuto Cellini with which the Popes "used to curse the caterpillars." A charming tale tells how "all the bells in Europe were rung in 1456 by order of Pope Calixtus III, to scare away Halley's comet, which was supposed to be in some way identified with Mohammed II, who had just taken Constantinople." As the teller remarks, "the comet left, but Mohammed stayed."

It is probably not common knowledge that a "peal" of bells is any number of changes above 5,000, which can be rung by seven bells and over However, it counts as a peal if five or six bells repeat their extent, *i.e.*, their full range, the requisite number of times to make up the 5,000. Twelve bells can ring 479,001,600 changes!

The art of ringing is not an easy one; it needs both knack and strength. A fine used often to be exacted from the ringer who "overthrew" his bell, the inconvenience of doing which is that it results in a broken stay as well as in a broken rhythm.

Mr. Nichols' book is certainly "authoritative," as the saying goes, and though the writer is a little inclined to call Shakespeare not Shakespeare but "that great master of the English language," it is also very readable.

P.B.

ATOMIC STRUCTURE AS MODIFIED BY OXIDATION AND REDUCTION By William Colebrook Reynolds, D.Sc. (Lond.), F.I.C., A.R.C.S. London: Longmans, Green & Co, Ltd. 7s. 6*d*. net.

As is partly indicated in the first and last sentences of his preface, this author has failed to comply with two very sound canons which, on this side of the Atlantic at all events regulate the form in which new contributions to the progress of the experimental sciences are promulgated

The sentences in question run respectively as follows: "In this small volume the results of a theoretical investigation of the structural changes which occur in atoms during the processes of oxidation and reduction are recorded;" and "The size of the volume has permitted but scant reference to the publications of other workers and writers on the subject, but the timely appearance of Mr. Douglas Clark's 'Basis of Modern Atomic Theory' has made the compilation of bibliographies on this subject unnecessary."

It is an extremely valuable general rule, to which no doubt reasonable exceptions are to be made, that new matter must in the first instance be communicated to an appropriate learned society; and must have run the gauntlet of the publication committee of that society before being offered to the public with the authority of text-book form. Human nature being what it is, it would be idle to deny that hardship to individuals sometimes results from this rigid control, or that valuable ideas may sometimes have been temporarily suppressed; but no one with first-hand knowledge could doubt that the alternative would lead to far worse consequences.

In the present volume, not only is this sound principle contravened, but the reader is nowhere specifically informed that it has been so contravened: the scarcity of references to original sources is such that he might well suppose that Dr. Reynolds's views had previously been put forward elsewhere in the orthodox manner.

A second and still more vital principle, to which it is difficult to imagine any exception, is that, in whatever form new contributions may be published, no doubt must arise as to what portions of the matter are submitted as original, and what portions are due to previous workers. Unfortunately this rule also is neglected; and there are not lacking occasions on which a chemist or physicist, not being a

pecialist in the particular subject of atomic structure, might be led to erroneous onclusions in this regard.

Dr. Reynolds begins by presenting a particular view of atomic structure, with eference to the extra-nuclear electrons, and by relating this view to the periodic lassification of the elements. He then discusses in this light the rationale of atomic ssociations (using the term in its widest sense), the oxidation and reduction of rganic compounds, the action of chromophores, the emission and absorption of adiation, the conduction of electricity through solids, and the phenomena of nagnetism. In a final chapter he examines some of the difficulties inherent in any f the modern views of atomic structure, and puts forward views of the nature of lectricity and ether.

While much of what he proposes is not lacking in interest, unsoundness sometimes ccurs, as in the suggestion on p. 22 to the effect that the phase-change from vapour to iquid may be due to a reversal of magnetic polarity in one of the paired shells of olliding molecules; a view which is probably to be connected with his belief, xpressed on the following page, that in liquids "attraction prevails over repulsion." This last, of course, is simply not the case. all stable liquids require, like vapours, ome external pressure to contain them in their existing volume, the mutual attracions of the molecules being quite definitely insufficient to prevail over the repulsions though it is true that the disparity is in general less for liquids than for vapours. urthermore, it is a familiar fact that a gradual change from undoubted vapour o undoubted liquid can quite easily be brought about by proper experimental eans without the appearance at any stage of a discontinuous change in properties uch as would mark the sudden reversal of magnetic shells.

With the above must be contrasted the much sounder view of liquefaction roposed on p. 110. To this one could not bring any objection, save that it is in the ature of a speculation unsupported by much definite evidence; an objection hich, one fears, is only too applicable to a great part of the contents of the book.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

NDAY, DECEMBER 3. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

hemical Industry, Society of, at Burlington House, W. 8 p.m. Dr. L. A. Jordan, "Scientific Aspects of Paint Technology."

lectrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as applied to Steam Generation."

ngineers, Society of, at Burlington House, W. 6 p.m. Mr. F. H. Mackintosh "A 'One Man' Borehole Outfit."

eographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Captain B. S. Thomas, "The South-East Borderland of Rub' al Khali."

oyal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

ictoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. J. A. Fleming, F.R.S., "Matter, Energy, Radiation, Life and Mind."

niversity of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. E. Allison Peers, "A Century of Catalan Poetry (18?0-1928)." (Lecture V).

At King's College, Strand, W.C. 5.30 p.m. Rev. H. Maurice Relton, "Reconstruction of Dogma."

ESDAY, DECEMBER 4. Chadwick Public Lecture, at 90, Buckingham Palace Road, S.W. 6.30 p.m. Mr. H. C. Adams, "The Drainage of Basements and Low-Lying Areas and the Prevention of Damp."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Colonial Institute, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Address by Mr. J. B. Walker on "Seeking Successful Settlers."

Electrical Engineers, Institution of, at the Technical College, Leicester. 6.45 p.m. Mr. H. Cotton, "Polyphase Commutator Motors and their Application."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 7.30 p.m. Colonel Sir Charles F. Close, "Some Aspects of the Work of the Ordnance Survey."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. A. G. Lobley, "Electric Furnaces."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds." (Lecture III).

Transport, Institute of, at the University, Bristol. 5.40 p.m. Mr. F. R. Innson, "Staff Organisation for Road Transport."

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture IX).

At University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture IV).

At Westfield College, Hampstead, N.W. 5.15 p.m. Mr. Humbert Wolfe, "Verse and the General Reader."

WEDNESDAY, DECEMBER 5. Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Mr. A. Scott Dodd, "The Natural Occurrence of Boric Acid in Fruits." (2) Messrs. John Evans and A. O. Jones

"Chemical Tests for Drunkenness." (3) Messrs. C. A. Adams and J. R. Nicholls, "The Analysis of Mixtures containing Acetone Ethyl Alcohol and Iso-propyl Alcohol," (4) Mr. J. R. Nicholls, "The Specific Gravities and Immersion Refractometer Readings of Dilute Mixtures of Acetone and Water." (5) Mr. J. J. A. Wijs, "The Wijs Method as the Standard for Iodine Absorption."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Meeting of Wireless Section.

Geological Society, Burlington House, W. 5.30 p.m. Mr. J. Walton, "Recent Improvements in the Technique of Examining Fossils, and their bearing on the Nature of Fossilization"; Dr. R. S. Sandford, "The Erratic Rocks and the Age of the Southern Limit of Glaciation in the Oxford District."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. Stanley Hopkins, "Constant Pressure Thermal Storage."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Mechanical Engineers, Institution of, at Liverpool. Mr. W. A. Benton, "Weighing Machinery." (Joint Meeting with Liverpool Engineering Society).
At Mappin Hall, Sheffield 7.30 p.m. Prof. Dr. F. C. Lea, Chairman's Address.

Metals, Institute of, at Thomas' Cafe, High Street, Swansea. 7 p.m. Mr. R. M Dodge, "Refractories"

Microscopical Society, 20, Hanover Square, W. Meeting of Biological Section.

North-East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. H. A. Morham, "Feed Water Heaters."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Dr. R. Fortescue Fox, "Rheumatism in relation to Industry."

United Service Institution, Whitehall, S.W. 3 p.m. Wing-Commander R. B. Maycock, "The Employment and Development of Flying Boats."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. Ruggles Gates, "The Indebtedness of Industry to Pure Science." (Lecture VIII—"The Relation of Botany to the Grain, Rubber and Cotton Industries.")
At the London School of Economics, Houghton Street, W.C. 6 p.m Captain Vaughan, Demonstration of the Ellis Book-keeping Machine.
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Dr. J. Percy Bruce, "Lin Pang; one of China's Rebels."
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Lirica del Paradiso." (Lecture V).
5.30 p.m. Prof. A. E. Richardson, "The Housing of Books."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Dragutin Subotic. "The History of Serbo-Croat and Slovene Literature in the 19th Century." (Lecture I).

THURSDAY, DECEMBER 6..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Capt. A. P. Thurston, D.Sc., "Control of Aeroplanes by Alulas."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. U. R. Evans, "The Mechanism of Corrosion." (2) Messrs. E. H. Farmer and W. D. Scott, "Properties of Conjugated Compounds." Part VI.—"The Dibromination Products of Cyclic Butadienes." (3) Messrs. E. V. Bell and G. M. Bennett, "The Stereoisomerism of Disulphoxides and related Substances." Part IV.—"Di- and tri-sulphoxides of Trimethylenetrisulphide." (4) Messrs. G. M. Bennett and G. H. Willis, "The Structure of Organic Molecular Compounds."

Chemical Engineers, Institution of, at Burlington House, W. Conference on Drying. 10.30 a.m. Mr. S. T. C. Stillwell, "The Seasoning or Drying of Timber"; Mr. A. T. Henly, "Tunnel and Stove Drying." 2.30 p.m. Mr. J. A. Reavell, "Film and Spray Drying"; Prof. J. W. Hinchley, "Drying by Pressure."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. A. E. Foster, P. G. Ledger and A. Rosen, "The Continuously Loaded Submarine Telegraph Cable."

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. W. S. Sparrow, "English Furniture and Woodwork from 1750 to 1800."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. F. C. Lea, Chairman's Address.
At Glasgow. General Discussion on "Steel Castings." (Joint Meeting with Scottish Branch, Institute of British Foundrymen).

Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Dr. Ezer Griffiths, "Research Carried out for the Engineering Committee of the Food Investigation Board during 1927."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir R. Paget, "Human Speech and Expression by Gesture."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.15 p.m Prof. Eccles, "Pierre Corneille." (In French). (Lecture X).
At King's College, Strand, W.C. 5.30 p.m. Mr. C. H. Driver, "Morelly and Mably."
5.30 p.m. Mr. Ifor L. Evans, "Modern Roumania Economic Reconstruction."
At University College, Gower Street, W.C. 5.15 p.m Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 450-750 A.D" (Lecture VI).
5.30 p.m. Prof R. Coupland, "The After Effects of the American Revolution on British Policy" (Lecture III).
8.30 p.m. Miss Margaret A. Murray, "Art and Architecture of Ancient Egypt" (Lecture III).
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Prince D. Sovatopolk Mirsky, "Tolstoy." (Lecture IX).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "Michael Angelo."

FRIDAY, DECEMBER 7 Chemical Engineers, Institution of, Burlington House, W. Conference on Drying. 10.30 a.m. Mr T. J. Horgan, "Rotary Dryers", Mr. G. W. Riley, "Vacuum Drying." 2.30 p.m. Dr S. G. Barker, "The Hygroscopic Nature of Textile Fibres", Mr. B. J. Owen, "The Drying of Agricultural Products", Mr. A. Chapman Barnes, "Some Drying Problems in Tropical Africa."

Chemical Industry, Society of, at the Geographical Hall, Manchester. 7.30 p.m. Dr. Auer, "Colloid-Chemical Changes in Rubber and other Unsaturated Organic Compounds."

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. C. H. Faris, "The Application of Electro-Deposited Metals to Engineering."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m Mr. J. G. C. Leech, "St. Austell Detritals." Mr. H G. Smith, "Some Features of Cornish Lamprophyres."

Junior Institution of Engineers, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Lt.-Col J. T. C. Moore-Brabazon, Presidential Address, "The Future of Coal in relation to Industry."

Mechanical Engineers, Institution of, Storeys' Gate, S.W. 7 p.m. Mr. E. T. Elbourne, "Marketing Engineering Products Overseas."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne, 6.30 p.m. Mr. K. O. Keller, "Combustion and its Difficulties in Marine Oil Engines."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. F. W. Thomas, "Weak R. in Central Asia."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Sydney Smith, "Babylonian Amulets."
5.30 p.m. Sir Mark Hunter, "Shakespeare's Clowns."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odložilik, "England and Bohemia." (Lecture I).

SATURDAY, DECEMBER 8..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Robert Aitken, "Life and Traditions in the Spanish Rioja."

Royal Institution, 21, Albemarle Street, W. 3 p.m., Mr. Walter Bayes, "The Gulf between Painter and Public."

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FRIDAY, DECEMBER 7th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, DECEMBER 12TH, at 8 p.m. (Ordinary Meeting.) G. G. BLAKE, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice." SIR OLIVER J. LODGE, M.A., LL.D., D.Sc., F.R.S., will preside

FRIDAY, DECEMBER 14TH, at 4.30 p.m. (Dominions and Colonies Section.) THE RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D., "The Improvement of Negro Agriculture." DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.L.S., F.R.S., will preside

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 28TH, 1928. THE RIGHT HON. THOMAS WILES, P.C., in the Chair.

A Paper on "The Port of London" was read by MR. J. H. ESTILL, O.B.E., Commercial Manager, Port of London Authority. The paper and discussion will be published in the *Journal* on December 28th.

DR. MANN JUVENILE LECTURES

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows:-

LECTURE I.—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES. This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

WEDNESDAY, NOVEMBER 21ST, 1928.

HIS EXCELLENCY THE SWEDISH MINISTER in the Chair.

THE CHAIRMAN said he felt greatly honoured at being invited to preside over a meeting held in connection with the Royal Society of Arts, which had exercised such a great influence in the life of Great Britain. The lecturer, Professor Stebbing, had just returned from Sweden, where he was sure he had made many friends, and he was confident the lecture would prove of very great interest.

The following paper was then read:

FORESTRY IN SWEDEN: ITS IMPORTANCE TO AND INFLUENCE ON GREAT BRITAIN.

By E. P. STEBBING, M.A., F.L.S., F.R.S.E.,

Professor of Forestry, University of Edinburgh.

Some years ago during the War, as an outcome of investigations I had been carrying out for several years into the timber resources of the World, especially the resources in soft woods, I had occasion to write two papers, the one dealing with the forestry resources of Sweden, and the other with those of Finland. In the short period of a decade and a half the forestry position of both countries has changed very considerably and in several interesting and important directions.

Considerable attention has been recently drawn to Sweden, her forests, and forestry problems, owing to the enthusiasm and *éclat* with which the Centenary of the State Forestry College was recently (October, 1928) celebrated

at Stockholm and the publicity given to the proceedings. Numerous delegates from foreign countries attended the celebrations, which were graced on several occasions by His Majesty the King and Their Royal Highnesses the Crown Prince and Princess; and the delegates were afforded an altogether exceptional opportunity of making themselves acquainted with the position at which forest management has attained in Sweden at the present day. There are points in this management which appear well worthy of consideration by foresters in Great Britain. Whilst portraying, therefore, the efficient management now in force in Sweden an endeavour will be made to indicate directions in which, with suitable modifications, Swedish practices might be adapted to this country. A review of the present methods of management of the forests, interesting as that management, in its varying aspects, is at the present day, would be incomplete without touching upon the other important economic factors they present. I allude to the great value to us and to our industries of the Swedish exports, which reach this country and have been coming to our shores and been absorbed by our industries in ever-increasing amounts during the past 60 years and more.

The total land area of Sweden amounts to 102 million acres, of which 57% consists of forest land, exclusive of marshes, bog land, &c., covered with a more or less scattered tree growth (some of it analagous to the *tundra* of North Russia). The proportion of forest varies in the different parts of the country, to some extent being dependent upon climatic conditions. The country being elongated from north to south the climatic conditions are of a ruder type in the north, and growth, especially tree growth, correspondingly slower. The soils over this large area of forest country are scarcely suited for anything but forestry, consisting chiefly of stony moraine soil and, in certain localities, of fertile calcareous moraines and clays. As at present ascertained, the total forest area amounts to about 58 million acres.

From the forestry point of view Sweden may be divided into three parts, Norrland (north), Svealand (central) and Götaland (south). The State and other public forests are mainly situated in the north—31% as compared with 13% and 8% respectively in the central and southern parts; the largest forest owners are the private limited timber companies who own 35% of the forests in the north, 31% in the centre and 9% in the south; next come the large landlords with 1%, 9% and 11% respectively; lastly, the small landlords, including a large number of farmers owning small forests, with 33%, 47% (in north and central), and the large area of 72% of the forest tracts of the south. The case of these minor private forests or peasants' forests as they have been termed is of very considerable interest and will be dealt with subsequently. From this division in the ownership of the forests it follows as a natural outcome that the forestry work in Norrland and the greater part of Svealand is in the hands of, and is carried out by, the large exploiters, the State and the big timber companies who provide the bulk of

the timber, wood pulp, &c., for export. In the south, forest operations are on a smaller scale, and are connected in the first instance with providing for the requirements of the much denser agricultural population to be found in this region. This does not mean that there is not a considerable area of forest in the south, the figures for area proportions from north to south being roughly 13, 5.7 and 4.9. A large proportion of the latter area consists of young stands, and a knowledge of the large exports which Sweden has sent to this country and elsewhere during the last sixty years provides the reason. For the southern forests had to bear the brunt of the lumbering of the early days, and at that period commercial forestry or lumbering governed the policy of Sweden in order to provide the materials with which to supply her own important iron industry and to capture the European softwood markets.

In addition to the forest area proper, there remain considerable tracts of mountain land and mosses and bogs in Norrland and areas of the latter in Svealand. The forest land areas in Sweden are consequently not regarded as fixed in extent. Whilst the private forest owner is allowed to clear, fell and bring suitable forest lands under agriculture, both the State and private owners are engaged in operations of great importance, and on an increasing scale, with the object of afforesting some of the peat and bog lands in the north and centre The area of such lands considered suitable to treatment amounts to 3,750,000 acres.

The forest flora of Scandinavia is well known, but it will be necessary to briefly draw attention to certain characteristics. The great Scandinavian timber belt, which stretches from Norway through Sweden, Finland and North Russia into Northern Siberia, consists primarily of conifers, the softwoods comprised by the Scots Pine and European Spruce mixed with Birch and a few other hardwoods. In Sweden the dominating type is pine (*Pinus sylvestris*) and spruce (*Picea excelsa*), occurring either pure or in mixture. The hardwoods in comparison with this dominant type play a much smaller part. At the upper limit of the forest line in the northern mountains the birch (*Betula alba*) occurs, which has merely a protective value. Below and covering a large area of country stretching into Central Sweden the two conifers occur mixed with birch, aspen and alder in smaller and varying amounts, the first-named tree being the commoner. The coniferous forest type stretches into the south of the country but several other hardwoods occur such as oak, beech, lime, elm, maple, ash and so forth. Travelling up from the extreme south, the beech region is passed through, in which the beech and oak form an important characteristic of the forests. Botanically speaking, the boundary between the northern and southern coniferous regions of the country is the northern climatic limit of the oak. Summing up, from the economic point of view, the coniferous species are the chief factor in any consideration of the forests of Sweden, with birch as a species of subsidiary value throughout the country. The growth of the conifers in the north is far slower than in the south, the average coniferous

rotation in the latter being 80 years, whereas it is roughly 160 years in the north.

A factor to which consideration will be given later has an important present-day bearing on the proportion of the pine and spruce in the mixed forests of these two species. The pine is known in forestry as a light-demanding species, the spruce a shade-bearer—in other words, young spruce will stand a greater amount of shade from larger neighbouring trees than pine. Up to comparatively recently the pine had a greater economic value than the spruce. There have been, however, some important changes in connection with markets and exports during the present century.

The sawmill industry still remains the largest consumer of timber in various forms. The most characteristic feature in economic development of recent years, however, is the gigantic expansion of the wood-pulp industry, a factor not without its importance to the press of this country. Sweden occupies at the present day the premier position amongst the sulphite-producing countries in Europe; and its exports of wood-pulp are probably larger than those from any other country. The importance to Sweden of this position is readily perceivable. The wood-pulp industry is the foundation of her paper-making industries, and further, it affords a valuable economic support both to the saw-mill operations in utilising waste, and, even more important, permits of adequate and repeated thinnings being made in the young woods, since the material therefrom is saleable.

Some curious facts have come to light on the subject of the variations in the proportions of the population of Sweden employed in the different industries. A considerable decrease in the numbers employed in agriculture took place between 1870 and 1920, in spite of the area cultivated increasing by 50%. The decrease is attributed to the increased use of machinery in agriculture. The following figures for the populations employed in agriculture, industries and commerce and in the Public Services and professions between 1751 and 1920 are not only of interest, but have some significance for Great Britain. The figures are given for percentage of population: 1. *Agriculture with kindred industries* (forestry, &c.), year 1751, 80%; 1840, 81%; 1870, 72%; 1900, 54%; 1920, 44% *Industries and Commerce*, year 1751, 10%; 1840, 11%; 1870, 20%; 1900, 39%; 1920, 51%. 3. *Public services and professions and other trades*, year 1751, 10%; 1840, 8%; 1870, 8%; 1900, 7%; 1920, 5%.

The above figures are of interest from a two-fold point of view, if we omit the fact that bureaucracy appears to be on the decline in Sweden. Firstly, fifty-one per cent. of the population is employed in industries, the most important of which are those connected with the forests and their output. Secondly, forty-four per cent. of the people are employed in agriculture and kindred industries, chiefly forestry. Three-fourths of the arable land in Sweden is in the hands of small landlords, and the bulk of the agriculture is carried on by the landowners themselves or the members of the family. This has brought

about the closest connection between agriculture and forestry ; for, as will be shown later, a considerable proportion of the agricultural labour, including the small proprietor of a farm and his family, is employed in the forests for part of the year, especially during the winter lumbering operations.

Before dealing with some interesting sylvicultural aspects of the Swedish forests and developments in extraction and conversion of the forest produce, a brief glance at the historical development of the conservancy of the forests will be necessary.

From an early date the recognition of the value of a forest law made its appearance in Sweden ; for laws of this type existed in the latter half of the sixteenth century. The main basis of these laws, which only applied to parts of the country, was to impose restrictions upon the owners' right to dispose of certain types of forest in their ownership, mainly protection forests.

The real commercial development of the forests took place during the latter half of the 19th century. Throughout this period the commercial interests became more and more powerful, and the efforts which had their origin with Israel Adolf av Strom, who was the founder of the State Forestry Institute (now the State Forestry College), in 1828, and advocated the introduction of scientific conservation methods, were gradually overborne ; for the official classes representing the State to a more or less extent, backed up the timber companies (who had acquired a considerable portion of the more valuable forests, chiefly by purchase from the farmers), in their efforts to obtain a predominating position in the European soft wood markets. To some extent this expansion of the timber and wood-pulp trade had been beneficial, for it had opened up and exploited large tracts of forests which had previously been unexploitable.

The lumbering of the forests, which was proceeding on an enhanced scale year by year, led on the one hand to a revival of interest in systematic and scientific conservation, whilst on the other hand it began to be perceived that the increased exploitation was threatening the future of the forests as a whole. The Government became alarmed at the position which had arisen, and a Committee was appointed in 1896 with instructions to report on the steps to be taken, by way of legislation, to institute some control over private forestry throughout the country. Discussions took place for some years, but it was not till 1903 that a general forest law was enacted which came into force in 1905. The basis of this law was the enactment that the fellings made in forest areas must be replaced by new young crops within a reasonable period. Considerable progress was made under this law, but the outbreak of the Great War led to enhanced demand and greatly increased fellings to take advantage of the extraordinary prices prevailing. To a certain extent, in the interests of the prosperity of the country, some of these extra fellings were justifiable, but they brought to a head the danger facing the forests as a whole and the future of half the trade of the country. Some provisional forest legislation was

passed during this period, chiefly aimed at the protection from felling of the younger age classes in the forests.

The general forest Act of 1905 applied to the whole of the country where there were no special forest laws (chiefly having reference to mountain protection forests and coast forests), in force. The main basis of this Act was to secure satisfactory regeneration of felled areas. Separate bodies termed Forest Conservation Boards were formed, one for each revenue district (county) in all parts of the country subject to the Act. These Forestry Boards consisted of 3 members, one being appointed by the Crown as Chairman, a second by the County Council, and the third by the County Agricultural Society. Each Board had under it a fully trained forest officer termed the County Forester with a number of Assistant Foresters (or Rangers), and Woodmen or overseers under its orders.

In 1924 the total staff under the Boards comprised 34 County Foresters and 205 County Rangers, and 18 Seed Extracting Superintendents, 40 office clerks and a strong staff of woodmen. The Boards were given, each in its county, a remarkably independent position, thus enabling them to adapt their activities to the existing local conditions. They are, in fact, responsible for the enforcement of the provisions of the Act whilst at the same time having the authority to advise and assist in the proper management of all areas of forest within their jurisdiction. The 1905 Act was amended in 1923 by the Forest Conservation Law, which only permits fellings to be made in the younger age classes of the forest in the form of properly marked thinnings. The Boards were also granted powers to prevent fellings for sale purposes being made on such a scale that Estates might not be able to provide for their own timber requirements in the future.

The outcome of these Acts and the enlightened but firm manner of their application carried out by the various Boards, combined with the advice they have tendered, has resulted in a great improvement in forest management throughout the country. Especially has this applied to the small areas of woods some no more than 75 acres in extent, in the ownership of farmers (the farm-forests as they are termed), some of which are reported to be excellently managed.

The money grants made to the Boards to enable them to carry out the duties allotted to them are obtained by a special tax of 1.3 per cent. on the stumpage value of the timber. Perhaps one of the most valuable results of the work of the Boards is to be found in that important matter of selecting the trees for annual or periodical fellings in a wood. It is said that more than half the timber now felled in private woods, more especially in those of the farmer-owners, only takes place after the trees have been selected and marked for felling by the officers of the Boards. It will be evident that the Boards, owing to their composition, have at their back the County Councils and Agricultural Societies of the particular County they represent. The special and varying forestry

conditions of different counties can therefore, within the limits guiding the forest policy for the country as a whole, be given full effect to.

It may be suggested that in the position to which forestry in Great Britain has attained at the present day, the methods to which Sweden has gradually arrived, after passing through a period of grave danger to her forests, merit a careful study and consideration. If we omit for the present the recently formed plantations and Crown forests, the rest of the woods in this country are in private ownership. Many of these are in a poor condition and, owing to changes in ownership occasioned by the heavy death duties and the burdens of the Great War, stand in a perilous position. To the forester the position of these woods, occupying a forest soil which, however impoverished, offers greater possibilities than the afforestation of bare lands, must be fraught with the gravest anxiety. Controversies in the press have shown how varying are the conditions in the different counties, both in connection with the maintenance of existing woods and in obtaining and planting up bare lands. It appears not impossible that the inauguration of forestry in Great Britain, and that difficult matter of arousing the interest of the public in this important question might progress with greater rapidity and a minimum of friction if the lines upon which County forestry has been improved in Sweden were carefully studied with the object of making a trial in Great Britain of such as were suitable.

The Swedish Forest Acts have not had the same importance to the management of the larger privately owned forests. Here, as in the case of the State forests, owing to the large capital involved, the introduction of a more rational management combined with the regeneration of cut areas had made its appearance in the early years of the present century. The expenditure so incurred has been necessitated if the concerns are to be kept on a working basis, so far as the provision of the raw material for the mills, &c., is concerned ; it has also been rendered possible by the improved facilities for marketing the smaller classes of timber, particularly for wood-pulp. The research work which has been instituted both by the State and some of the larger timber companies has also led to better management in the forest and improved methods of exploitation, combined with the employment of men trained in the science of forestry. In other words, there has come about a close association between the practical commercial timber man and his scientifically trained forest confrère ; and it is admitted on either side that both have gained enormously through the association.

An important economic factor already alluded to has necessitated a reconsideration of the degree of commercial importance of the chief species of the Swedish forests. Up to comparatively recently, the Scots Pine was the most valuable species since it provided the best-priced material for the sawmills. It had therefore been favoured from the sylvicultural point of view in regeneration work at the expense of the spruce, both in naturally regenerated areas and for new afforestation work. Owing to the enormous development of the wood-

pulp industry, spruce is now in greater demand, and, further, in Southern Sweden the spruce produces a larger volume to the acre. The spruce is, therefore, where locality factors are suitable, economically the most profitable crop to grow at the present day.

Another development is in connection with the birch previously regarded, owing to its encroachments in the coniferous forest, as a forest weed, as is so often the case in Great Britain. Investigations which have been carried out in connection with forest soils have proved, for Sweden at least, that birch has a very favourable influence on the improvement of the soil factors, a quality which is now regarded as of high value, especially in the soils of Norrland where there is so much raw humus. As will be shown subsequently, birch has by no means so useful a role in the south. Here it has taken possession of considerable tracts felled in the seventies and eighties of last century at the expense of the conifers which should be occupying the area.

It has been already shown that the supervision of the forests and of forestry work generally in the revenue districts is under the Forest Conservation Boards. The management of the State Forests is under a different Authority, the Forest Service Board with Headquarters at Stockholm. These forests comprise 13 Inspection Areas with 140 districts divided into 625 ranges; the area of the district varies with the importance and intensity of management of its forests. The seven most northerly inspection areas include nine-tenths of the State Forests. The State Service also manages the municipal and other public forests and the ecclesiastical forests. It also controls the management of the forest areas in the north which are under the special laws. The State forests are all under Working Plans, the calculated annual possibility or yield under these plans requiring the sanction of the headquarters Board. Rates and taxes are paid on the State Forests.

It is now proposed to glance at some of the sylvicultural aspects in the management of the forests. We may start from the general proposition that the aim of every Swedish forester is to obtain his new crop of young trees, after felling the mature one, by means of natural regeneration. For many reasons, this is not, at present, always possible and artificial work by sowing seed or planting has to be resorted to.

For the purposes of the sylvicultural treatment in force Sweden may be divided into two parts. On the large forest estates in the southern portion (i.e., South of the River Dalalven), the forests were either clear felled and regenerated artificially or treated under a shelter wood compartment method, under which a percentage of the trees are left standing over the area to provide seed for the development of the new crop. The clear fellings were often made over excessively large tracts, and the subsequent artificial regeneration work was said to have been done with seed or plants of doubtful origin and unsuitable to the locality. It is probable also that the inclement climate and excessive exposure exerted a considerable influence on the poor results attained. This

has now become recognised, and where clear felling is still resorted to the areas felled in any one spot are greatly restricted in size, in order that they may become regenerated either naturally by seed blown on to the area from the adjoining standing forest or by direct sowing, the ground where necessary being cultivated with a plough or other means. The expensive method of planting with nursery raised plants, practically the only method at present in force in Great Britain, is only adopted when the far cheaper methods are impracticable. When the new crop is obtained by leaving seed trees standing on the area the number so left is greater and follows the practice in other European countries where this method is well understood. Moreover, the increased value of the spruce, which stands more shade than the pine, has facilitated the introduction of the well known Continental methods, with suitable modifications such as the French modern *jardinage* and Gayer's and Wagner's strip methods, the latter still under trial. Artificial work is now greatly restricted and when adopted perforce is rendered as cheap as possible by labour-saving devices, strict attention being paid to the origin of the seed (chiefly used), or plants.

In Norrland in the North with the exception of the coastal districts and the lower portions of the large river valleys, where forest conditions approximate more nearly to the part of the country dealt with above, the position is very different. Here there exist large tracts of overripe forest producing but little increment. These forests are situated in the upper and interior parts of this northern region covering large areas. The problem before the forester, chiefly the State forester (for these are mainly State forests), is how to convert this forest type into a more profitable one. Research work on a considerable scale has been instituted with the object of endeavouring to solve this problem, So far the investigations tend to show that the seed of the pine of those regions possesses in certain years very little or no germinating power ; that artificial work with pine in past years has usually been a failure ; and that the chief cause of failure in the present condition of the forests must be looked for in the condition of the humus layer which, under the extremely bleak climatic conditions, undergoes little change, and may be characterised as a bad type of raw humus. Consequently the experiments now being conducted have relation to different types of felling made with the object of ascertaining the best way to bring about the decomposition of this raw humus layer ; to break up, in other words, the stagnant condition of the forest soil by promoting activity. It is recognised that once this condition has been brought about, artificial regeneration work will have to be resorted to. A point of great interest and importance which has come out of these investigations, in the words of the Swedish writer, is the following :—" That pine " (he is writing of the seed in the north) " is extremely susceptible to removal from one climatic area to another, even if the difference in temperature is very slight."

It is said that from 15 to 20 per cent. only of the areas felled annually are artificially regenerated either by direct sowing or planting ; the remainder being naturally regenerated.

The thinning of the woods now in force in Sweden is on a far higher plane than formerly. This has been greatly assisted by the demand for smaller dimensions of trees, especially for wood pulp. The demand for pitwood for the British collieries has, of course, existed for a long period. The average period of repetition of thinnings in the forest is now 10 years, but it is considered that under some conditions the period might be reduced to 5 years.

Even in the comparatively new work of afforesting the bare heaths and so forth, Sweden is paying particular attention to costs. Since a considerable part of this work is being undertaken by the trained expert foresters employed by the large companies, the fact that expenses are kept down and direct sowing is preferred where practicable to the more expensive formation by planting out plants raised in nurseries is understandable.

We find then that the work of creating new forests on the considerable areas of heaths and marsh and boggy ground forms no unimportant part of the forestry business in the country. This work is being mainly carried out by the State Forest Service and the large timber companies, but smaller proprietors are following the example thus set. The drainage of swampy forest ground, in order to obtain a good forest crop, has greatly attracted the interest of the smaller proprietors. The correct method of laying out and cutting forest drains and ditches has been brought to a high art during the last twenty years. Something over 3,000 miles of forest drains were cut throughout the country in 1925, a considerable portion by the big timber companies. Exotics are being used to some extent, but the work is chiefly confined to spruce and pine.

In connection with our afforestation programme in Great Britain, a point which it would appear requires serious consideration is the cheapening of the present high cost in formation of the plantations. The idea of formation by direct sowing has received but scant recognition by those responsible in this country. And yet we find it forming the main basis of similar work here in Sweden, and the same is the case in France where large areas in Auvergne and neighbouring districts of very similar a type to many existing in Great Britain are being afforested. France would certainly never face the expenditure (even when the extra cost of netting against rabbits is deducted) which we are incurring per acre of new plantation formed at the present time ; and a study of the position in Sweden gives evidence of the same condition of affairs.

As has been shown, the large landed proprietors own but a small percentage of the forests. But these forests have been managed on scientific principles for a long period of years, and some of the best forests, the "show" forests of Sweden, belong to the large landlords. It was this small body who first introduced a rational form of forest pasturage, which in the past has proved so destructive to the forests.

There remain for consideration the farm-forests and their management. It is here that the Forest Conservation Boards have done such good work. In the main they consist of small woods dotted about the country-side ; the State

forests, as a matter of fact, include a not inconsiderable number of the same size and type. These farm-forests are of very ancient origin, although till recently their management was on primitive lines and the pasturage to which they were subject was often excessive. The area of a forest of this type, on an average for the whole country, amounts to about 75 acres. The larger ones yield timber, apart from the owner's requirements, for sale, the buyers being the big timber companies who have to purchase in the market to enable their sawmills to be kept running full time. Under the Forest Conservation Boards, the improvement in the management of the farm-forests has made greater strides with the big farm-forest owners than the smaller ones. The thinnings and major fellings are marked by the forest staff of the Boards, working plans are prepared and advice given on all general details of management. It is held, however, that taking into consideration the period the Boards have been at work, the improvement in the management and the interest taken by the owners in the farm-forests as a whole has resulted in an advance which may be expected to increase yearly.

The farm-forests of Sweden and their method of management present, to my view, a problem of absorbing interest. As a result of death duties and the War, the break-up of large estates in Great Britain has resulted in the tenant farmers in many counties, especially in England, becoming the owners of their farms, and in many cases of the small woods standing within the perimeter of the farm lands purchased. The bulk of these woods are of broad-leaved species, oak, ash, elm, chestnut and so forth. These timbers have always had a value in this country both for structural and the finer cabinet, etc., work; and also to the people on the countryside. The Forestry Commission have not, as yet, shown little interest in these woodlands. Their present owners either have not the money or the knowledge to maintain them under a scientific management. And yet it is unthinkable that the public would witness their disappearance with any pleasure; yet without careful attention many of them are doomed.

Both in Sweden and in France and elsewhere in Europe methods have been introduced by which the efficient management of similarly owned woods has been made practicable, the continuance of their produce and the amenity and shelter they afford being thus assured to the population in their vicinity. It may be suggested that a study of these methods should enable us to find a way to preserve and make pay (or at the least cover the expenses of upkeep), the many beautiful woodlands scattered throughout the counties of this country. With the new position brought about in land ownership, this matter may be regarded as one of some urgency if forestry, as apart from mere afforestation work on bare lands, is to take its true position in the country. To those interested in this matter a study of the Swedish methods introduced during the last twenty years should prove of considerable interest.

There remains for consideration, in connection with the Swedish forests, the practical factors relating to the amounts of available materials in the forests,

and the exports of produce, in both of which Great Britain has a considerable interest. It has been shown that in the interior of Norrland as also in Svealand, there are large areas of mature and over-mature timber. These forests are being exploited, and since the increment is deficient the annual fellings necessarily exceed the increment being put on. In the bulk of the finer forest areas it is held that the age classes are more normal; though here again, in view of the large fellings, often clear fellings over considerable areas, made by the big timber companies in the latter half of the nineteenth century, which areas it was found difficult to regenerate, it is probable that in certain tracts the younger age classes are in excess. In southern Sweden there is a shortage of the old age classes, owing to the heavy fellings of 30-40 years ago; consequently in this region there are large areas of young forest in considerable portions, of which birch is predominant amongst the conifers.

These factors were well known, and with the object of obtaining statistics on the relation between growth and cutting, the Riksdag made a grant for a general survey of all the forests of Sweden. The survey was carried out by well known experts, and at the end of 1927 89% of the forests had been examined and reliable data obtained from the various districts. It is not considered that the survey of the remaining 11% will alter the figures acquired. Briefly, the results show that on the 51,000,000 acres of good average forest soil so far investigated, there are 1,480,000,000 cubic metres of growing wood (measured over bark), not including hardwoods of less than 5 centimetre diameter at breast height. The cubic contents amount to 1,025 cubic feet per acre, of which 83.5% are softwoods and the balance hardwoods. The total annual increment is calculated at approximately 50,000,000 cubic metres or about 30 cubic feet per acre. The distribution of the age classes throughout the whole country is as follows:—Blanks, 7%; 1-40 years, 23.7%; 41-80 years, 34.1%; 81-120 years, 15.1%; 121-160 years, 9%; over 160 years, 11.1%.

The volume of timber, as also the annual increment, is smaller than that of former calculations. But there is a better distribution of the age classes from which a permanent annual yield may be obtained than was anticipated. It is held, therefore, that it does not appear probable that Sweden will have to reduce her exports of forest produce generally, although both the amounts coming from different parts of the country may change, as also "the different groups of manufactures," an allusion, perhaps, to the fact that wood-pulp will displace timber in bulk of exports. It is also contended that, taking volume alone, the annual cut does not exceed the increment. It is admitted, however, that timber cutting is carried out on a large scale in the more favourably situated forests, whereas the increment being put on in the young woods will only be available for use (as timber) in the future.

Apart from the State, and more important, the big Companies take a prominent place in Swedish forest activities. There are some 160 joint stock companies owning forests, the largest one in possession of a company amounting

to 750,000 acres of good forest soil. In these concerns forestry is combined with timber, pulp and iron industrial enterprises. Wood-working industries, including that important one, the match-making industry, also own forests. It is to these industries that the surplus produce from the farm-forests is sold. The larger forests owned by companies are in charge of fully trained foresters and are managed on lines similar to the State forests, the yearly fellings and thinnings being carefully marked by the trained officer. The latter is now-a-days, as we have seen, undertaking the work of afforesting, where possible, the waste marshy, etc., lands of the company's property which were formerly left neglected.

It is of interest to mention that the forest lands owned by the larger Companies were chiefly acquired after the middle of last century by buying the forests owned by farmers. Legislation has now put an end to this method of acquisition which, in most countries, is an unsound mode of land ownership.

Felling in the forest and extraction work to the conversion or exporting centres presents few difficulties in a country such as Sweden, where water facilities in the north and centre are abundant. Labour, mostly domiciled on farms in the vicinity of the forest, is abundant, and the farmers and their employees are conversant with forest work. The farmers bring their own horses with them when working in the forest. In the case of the State and large forests owned by Companies, a permanent staff is maintained throughout the year (supplemented when required), who occupy small tenant farms (small holdings), situated throughout the forests. Felling and transportation in the forests is paid by piece-work. In the northern and central parts of the country snow facilitates the transport of the timber to the waterways, and floating is the chief method of transport. In the south snow is less abundant, and waterways are scarcer. Forest produce is, therefore, taken by road to the railways and at times by canal. The length of the waterways used for floating purposes amounted to 19,000 miles in 1927, about 450,000,000 solid cubic feet of timber being extracted by this means. The annual cost of floating this material amounted to 26,000,000 Kr. (approximately £1,450,000), or about one-seventh of the cost by railway for the same distance at existing rates. The distance from the forest to the waterways varies from 1-4 miles only.

It must not be imagined, however, that these waterways were all naturally suitable channels for timber flotation. As a contrast to conditions in Norway, the gradient from the mountains to the low lying levels and the coast is comparatively gradual in Sweden and this facilitated improvement work. Large sums were devoted to the amelioration of the river and stream beds by blasting the rocks and so forth to enable the timber to be sent down with a minimum waste of time from the forest to the conversion and exporting centre and the minimum amount of waste from rock-breaking, &c. The presence of numerous large lakes also assists the floating by prolonging the period of high water due to the melting of the snows in the spring. In the words of a Swedish

writer, the position is summed up as follows :—" On the whole it may be said that a plentiful supply of timber of a high quality, a good demand from countries well situated from a transport point of view, a population well adapted for industrial requirements, and excellent transport channels, are the conditions upon which the export of forest products, which has been of such uncommon importance for the country's economy, has been able to rely."

And, from the point of view of the professional forester, a very excellent and unusual combination of conditions they are, even with the recognition that Sweden, by a bold expenditure in the past, has enhanced their natural value.

The chief factor governing Sweden's large export trade in forest produce is to be found in the fact that there are about ten acres of forest and eight cubic metres of annual growth per head of population. It is for this reason that so weighty a proportion of Swedish industries are based on the forests and their produce. The value of the exports of pulp, paper, &c., rose from £19,400,000 to £22,800,000 between 1924 and 1926, whilst wood goods of all kinds decreased from £15,900,000 to £14,300,000 during the same period.

In the case of Europe, Sweden at present holds the premier place as an exporter of soft woods, both in amount and in the high grade of its products as placed on the markets. Of these exports Great Britain took 41 per cent. in 1927 as against 32 per cent. in 1913.

The great asset to the country is the amount of conversion of the raw product which is undertaken in the numerous sawmills situated either (and chiefly) along the coast of Norrland at the mouths of the chief rivers, or on the many lakes of the country Most of these mills, some of which are of long standing, have been brought up to date so far as machinery, etc., goes. They used to be run by steam power consuming the waste of the mill. Latterly, however, electric power (from water) is supplanting the old method, since much of the waste can now be used for pulp wood. An average Swedish export sawmill has an annual output of 7,000 to 10,000 standards (1 standard—1,980ft. board measure), but the largest have an output of from 30,000 to 35,000 standards. The produce is converted into deals, battens, boards, staves, box materials, laths, mouldings, &c., a normal annual export of these materials amounting to approximately 1,000,000 standards.

Perhaps the factors which stand out most clearly from this review are, firstly, the belief that there will be no falling off of the exports, though so far as Great Britain is concerned, it appears as if there may be a drop in the larger timber sizes in a comparatively near future ; secondly, that a good conservative management is now in force throughout the country, under which there is every hope of introducing an effective management even into the smallest of the forest areas owned by the peasant farmers ; thirdly, and most significant, that the Company forest owners have realised that serious attention has to be paid to the regeneration and the correct thinning of their forest areas if they wish to maintain them in perpetuity as commercial forest propositions.

Lastly, Swedish forest officers, timber merchants and Government alike, have recognised that if the output of the large forest area, upon which the life of the country and the livelihood of so large a proportion of the population depends, is to be maintained or increased, research work must be encouraged. Sweden's position as regards research in forestry is quite different from that of Great Britain, and she is justified in devoting considerable sums of money to this matter. She has a large area of forest in existence, her Government derive a certain income from the State forests, and a considerable number of important timber companies have a large capital invested in forest property. With the object of safeguarding this capital both Government and the large timber companies are annually making grants towards research. The Research Institute in connection with the State Forestry College, situated on the outskirts of Stockholm, is supplemented by research centres maintained by some of the large timber companies on their own forestry estates. Research work is thus decentralised on rational lines.

The various bodies interested in Forestry in its various aspects in Sweden, find a common meeting place in the Swedish Forestry Association, founded 25 years ago. It is held that this Society, as much as anything else, has brought together the landowner, the trained forester and the timber company representatives and has enabled the views held by each to be pooled and discussed, thus leading to a common recognition of the place each holds in the forestry firmament. That such a recognition exists is unquestioned. It is held that it is largely due to the activities and energy of the present Chairman of both the College and the Association, that remarkable man Admiral Arvid Lindman, the present Prime Minister of Sweden.

In conclusion, and at the risk of repetition, I would offer the suggestion that a study of Forestry management in Sweden at the present day offers several points meriting consideration by foresters in Great Britain.

Two of major importance. The first, that experiments should be made on a considerable scale, and be persisted in, with the object of forming plantations by direct sowing on suitably selected areas instead of the costly plantings. And second, we have in existence nearly 3,000,000 acres of woods in this country, and the Census, recently published by the Forestry Commission, has shown us roughly the composition and condition of these woodlands. The remarks upon these woodlands which have appeared in Annual Reports by the Commissioners would appear to show that they attach but a small value to much of this area; that in fact, they appear to view its disappearance, so far as a considerable portion of the hardwoods at least are concerned, with equanimity, or where conditions are favourable their replacement by conifers. Now one part of the forest capital consists of the soil, and this considerable area of woodlands covers a forest soil which, however depreciated by poor management, at least forms, it may be suggested, a more valuable item of forestry capital than that comprised in lands which have not carried crops of trees for a long period of

years. A study of the methods by which the County Forest Conservation Boards in Sweden are safeguarding and improving the large numbers of small woods in that country, should point a way by which we might solve the question in this country, and thereby save from disappearance a large proportion of the beautiful woods of oak, elm, ash and so forth which form a feature of the English countryside.

In conclusion, I should like to express here a sense of my great indebtedness to the Officers of the Swedish Forest Service and others for the kindly assistance accorded to us all in Stockholm during the Centenary celebrations. If a clear view of the position of Swedish forestry to-day has been made possible for the foreigner it is due to their efforts. To Professor Tor Jonson, Dean of the Forestry College, our thanks are due for the beautiful forest views with which the lecture has been illustrated; for he took great trouble in selecting the photographs from which the slides were made.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said they had listened to a most interesting lecture, and he thought it would be agreed that the emphasis which Professor Stebbing had put on the importance to England of the administration of the Swedish forests was quite justified. As had already been shown, the produce of Swedish forests was of such importance to the people of these islands that the more this was realised the more anxious must they desire to cultivate the best relations between the two countries. "Wood comes first," was a saying that used to exist in the timber trade, and he wished to apply it in that connection. He thought that British requirements for spars, boards, tar, and the various kinds of forest produce, constituted possibly the earliest big trade with Sweden. For some time Great Britain was vitally dependent on the Swedish forests, and that was the case with all the northern European Powers which obtained the control of the sea. The Hanseatic League was brought to agreement with Sweden in order to get timber; when Holland succeeded to the position of the leading sea power, she had the same experience; and when England rose above the horizon of the sea the same thing was repeated. He noted, for instance, that Townshend in 1715 wrote a letter to the King complaining that if the Admiralty was barred from acquiring the necessary stock of forest produce from Sweden then "it would be impossible for his Majesty to fit out any ships for next year, and the whole navy of England would be perfectly useless." That statement seemed to give some evidence of Sweden having, unknowingly, taken a part in the building of the British Empire and the maintenance of the English fleet. At the present time statistical tables bore out the extent to which this country in other respects was dependent on the forests of Sweden. British imports from Sweden in per cent. of total imports were as follows:—Printing and wrapping paper, in 1913, 22.8 per cent.; in 1927, 24.6 per cent.; wood pulp, in 1913, 38.6 per cent.; in 1927, 36 per cent.; soft wood (hewn and sawn), in 1913, 17.8 per cent.; in 1927, 14.9 per cent.; planed or dressed timber, in 1913, 60.8 per cent.; in 1927, 61.5 per cent.; pit props, in 1913, 11.3 per cent.; in 1927, 11.5 per cent. Those figures showed a constant progresssion of imports from Sweden, which was the more remarkable as the total imports of

those materials into England from all countries had greatly increased between 1913 and 1927, the increase in paper being 27 per cent., in wood pulp 49 per cent., and in wood and timber 16 per cent. It was of great interest to know that the Swedish forests would not be exhausted. As a matter of fact, the reverse was happening. They were increasing both in value and in area. They were better cultivated, and the population took a great part in the planting of the moors and the more or less barren land with seeds to grow new forests. Even the school children were encouraged to take a part in the national campaign for afforestation. During the last thirty years Sweden had awakened the national consciousness in this respect. After the able lecture to which they had listened, it was not necessary for him to enlarge upon the subject, but he wished to say that, just as an Englishman loved the tree, so the Swede loved the forest; and forests covered 57 per cent. of the land, *i.e.*, an area double the size of England and Wales. It was quite remarkable to note that the best cultivated forests were in the hands of the Government and the companies—in all, 45 per cent. of the entire country, of which 16 per cent. was State forest. They could thus feel quite sure that the British market had a steady and permanent supply of the important raw material represented in Sweden's forests. With the increasing demand for timber, sulphite and pulp in the world that was a factor which ought to be taken into consideration. He was very pleased that the lecture had been given, and that it had been listened to with such great attention. It was a sign that the people on this side of the North Sea realised the great and growing interests they had in common with the people of Sweden, and which, he was convinced, would not cease to exist.

MAJOR JOHN COSGROVE, D.S.O., M.C. (Forest Products Research Laboratory) said they had listened with very great interest to Professor Stebbing, and he was particularly interested to hear about the splendid sylvicultural work in Sweden. In England and in other parts of the British Empire they were often confronted with the problem of growing timber suitable for marketing, and some of the pictures shown on the screen that evening indicated why Swedish timber was capable of finding a ready market in this country and of being so popular. They noticed that the trees were particularly straight and that the boles were well formed, so that the resulting timber would be straight grained and capable of good manufacture. He thought that that little lesson in itself was very important, and one which should be kept in mind in England, particularly in view of the fact that we were now investing largely in afforestation work. In different parts of the Empire they were also obliged to give consideration to that question. He was also interested to see some of the methods of transportation, which were cheap, and of course, peculiar to the country, and the very economical manner in which the Swedes carried out their work. The cleanness of the felling seen in the pictures indicated careful attention and true economy, which were laudable aspects of Swedish work.

MR. F. PARKER SMITH said that as a paper maker he had been very interested in the lecture. In 1910 he had the honour of being asked to read a paper to the Papermakers' Association on the question of pulp, and he then went into the matter of Swedish supplies and also those of other European countries and Canada in relation to what could be done in this country. He would like to draw attention to one point. In 1910, they found from the reports of Professor Schlich that the actual consumption of timber in Sweden was then exceeding the growth by about 100,000,000 cubic feet; and the last report showed that it was practically 350,000,000 cubic feet in excess, but there were indications, from the progress that

was being made in Sweden in encouraging growth, that it was possible to get the normal production of timber in Sweden increased by 50 per cent. This showed what a very large margin of increase was possible with care. When one came to consider our own country in the light of Sweden, there were some 12,000,000 acres in England which were suitable for growing timber, and if this area was under timber, it would be posible, after paying all expenses, interest charges, labour, and the original cost of seeding, etc., to leave a profit of at least £1 an acre per annum during the whole period of 60 or 90 years' growth of the trees. This was a very important item because an increase in sylviculture would result in the establishment of other businesses which were ancillary to sylviculture and which would be of enormous benefit to the country.

It was estimated in 1910 that 11,000,000 acres would provide Great Britain with all the soft wood she imported either in pulp or in paper. It took, roughly speaking, 25,000 acres of timber to supply a continual growth of wood for 100 tons of paper per week. In England, while there was a good deal to be said for the small timber holdings, it was feared that the small beautiful woods which we saw might disappear, and the only way to overcome that was to copy the Continental method whereby a local Board laid it down that at least three trees should be supplied for every one cut down. The only way to attempt afforestation in this country was to take a whole watershed and plant that under the most approved methods, look after it thoroughly, and then pass on to another watershed and control that. Some time ago he drew up a chart as to what it would cost to plant 150,000 acres per annum. At the time he was able to show by the figures given that every eighty years there would be, he thought, a profit of £100,000,000! That was an actual fact, but in connection with such large figures it was no use the matter being attempted by private persons. It must be done by Government action. One of the difficulties they were up against was that as soon as they planted anything, rates had to be paid, and that if anybody planted a forest, there were at least two death duties in the life of that forest. These were some of the difficulties that had to be faced. It was necessary to recognise that land existed in England which could supply an enormous amount of timber, but which was going to waste increasingly every year.

PROFESSOR FRASER STORY referred to one or two points which impressed him during the lecture. He absolutely agreed with Professor Stebbing that what had been done in Sweden should encourage us to improve our methods in England; and he ventured to go farther and say that Sweden set a good example not only to Great Britain but to the whole of the British Empire. It was conserving its forests and regulating its fellings according to its annual growth in a manner that was not done in many parts of the Empire. There were a few remarks of Professor Stebbing, more especially in regard to the operations of the Forestry Commission, with which he could not quite agree. For example, the lecturer said in regard to direct sowing that this had received scant attention on the part of the Commission. He (the speaker) thought that was scarcely correct. It was true that they had not sown very large areas, but they were very much alive to the possibilities of that means of forming plantations. There was present that evening one of the officers who had been particularly active in advocating direct sowing in order to establish plantations. It was true that they were doing that more in England and Wales than in Scotland, and Professor Stebbing might have received his impression from the northern part of the country.

He thought that it must always be remembered that conditions in Sweden were really very different from those obtaining in Great Britain. It certainly was

true that they could, as it were, receive inspiration from the study of forestry in such a country, but it was only after the most careful investigation that they should adopt methods which were new from a country whose climate, soil and other conditions differed very considerably from our own. For example, there was the matter of natural regeneration. In Sweden they had a country which was under snow for many months of the year. The small seeds of the pine, spruce and other trees fell on to the snow, and were brought with the melting snow into the soil on the arrival of spring ; there was a much more rapid transition from winter conditions to summer conditions in Sweden than in this country ; the seeds germinated quickly and there was less growth of grass and weeds than we had ; in addition they had not the pest of rabbits. He did not hear any reference to rabbits in Professor Stebbing's address! These conditions made natural regeneration easier in Sweden and also in Finland. Moreover, we had not many fine old conifer forests to restock as in Sweden. The operations of the Forestry Commission had to be carried out almost entirely on bare land. It was only right that, where there were standing forests in private hands, they should continue under private enterprise rather than that large sums of money should be spent merely in the taking over of these forests by the State. Rather should they afforest afresh the bare land, and in order to do this they must obviously adopt some artificial method of sowing or planting.

MR. W. L. TAYLOR said that to anyone interested in forestry in this country Mr. Stebbing's lecture had been extremely interesting, for it was necessary that one should know what was going on in European countries, especially Sweden, where forestry had been a science for so many years. With regard to direct sowing, the position was rather as Professor Stebbing had just said. The Forestry Commission were stocking poor land - some of the poorest in this country. They knew that they could stock that land by planting, but they did not know with certainty that they could establish plantations by direct sowing. Direct sowing, however, had been done in Suffolk, in Dorset, on the hills in South Wales and in Devonshire for the last seven years- a small amount each year because there had been no money available for heavy expenditure in that way, so largely experimental. The work had shown promise, and he hoped that the method of direct sowing would be extended in this country year by year, as they got more experience.

DR. RUSHTON PARKER remarked that Professor Stebbing had said nothing about disease in Sweden. He would like to know whether Sweden was fortunate enough to have no signs of disease in trees.

PROFESSOR STEBBING, replying first of all to the last speaker, mentioned that Stockholm had not yet finished with its invitations to forestry countries and others interested, and next year it was going to have a conference on research work. Consequently, they might expect to hear a great deal about the research work which was being undertaken in Sweden, and, therefore, about disease in trees. He did not know that he could offer any remarks upon diseases and pests which might, or might not, exist in Sweden. As regarded the other speakers, he did not think he could enter that night into arguments on what were rather technical forestry subjects but he thought it was rather doubtful whether they could plant as much as 12,000,000 acres of land in this country to produce forest which would pay during the first rotation, or even possibly during the second rotation. A certain proportion of that area at the present moment was situated at an elevation beyond which it would not be practicable or profitable to plant until the lower areas had been

placed under tree crops. He fully agreed that it would be advisable to institute some method by which, when trees were felled in the small woods of the country, arrangements could be made for replacing them with young growth. In regard to the question of sowing, he thought Professor Story must have misunderstood some of his remarks. He would not for a moment imply that they should take over any existing woodlands. Far from it. He had simply drawn attention to the fact that in other European countries the Government Forest Departments had found methods under which small areas of privately-owned woods could be efficiently managed. So far as rabbits were concerned, they had to keep these out by means of fences and netting whether they planted or sowed up the areas. In regard to the amount of work done—he knew Mr. Taylor had done exceedingly good work in direct sowing—they had to depend upon the reports of the Forestry Commission. They would there find that the greater part of their energies had been devoted to afforestation by means of the nursery and young plants. He was not going to say they were wrong, but it seemed to him that the Forestry Commission should make efforts on a larger scale with direct sowing in order to cheapen first costs. Our climate was better than that of Sweden, and we had all the conditions in favour of making a start in the study of this question of direct sowing.

In conclusion, Professor Stebbing said he would like to propose a vote of thanks to his Excellency the Swedish Minister for presiding, and he personally thanked him for his exceedingly interesting remarks in connection with Sweden, her forests and their utility to Great Britain

The Chairman, in reply, referred to the progress that was being made in Sweden in the growth of timber in relation to consumption. It was difficult to give an exact calculation, but year by year the calculations showed better results. He was glad to propose a vote of thanks to the lecturer, who, he was pleased to note, appreciated that there was something to learn from Sweden. Lectures of the kind given that evening and their discussion were the means of promoting understanding, of encouraging friendship and of keeping contact

The vote of thanks having been carried unanimously, the meeting terminated.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

December 12.—G. G. Blake, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice." Sir Oliver J. Lodge, M.A., LL.D., D.Sc., F.R.S., will preside.

January 16.—Professor Charles R. Darling, A.R.C.Sc.I., F.I.C. "The Domestic Smoke Problem—Practical Solution."

January 23.—Sir Henry A. Miers, F.R.S., "Museums and Education." The Right Hon. the Earl of Crawford and Balcarres, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

January 30.—George Fletcher, "The Shannon Scheme and its Economic Consequences."

FEBRUARY 6.—SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture).

FEBRUARY 13.—CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms and their Insect Visitors."

FEBRUARY 27.—A. F. SUTER, "Resins."

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., "Modern English Architecture."

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced:

JAMES MORTON (of Morton Sundour Fabrics, Ltd.), "History of the Development of Fast-Dyeing and Dyes."

SIR GERALD BELLHOUSE, C.B.E., H.M. Chief Inspector of Factories, Home Office, "Safety in Factories."

J. F. CROWLEY, D.Sc., B.A., M.I.E.E., "Recent Developments in Vegetable Oil Extraction."

MAJOR T. H. BISHOP, M.R.C.S., L.R.C.P., D.P.H., "The Purification of Water."

LADY INGLEFIELD, "Lace."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

FEBRUARY 8.—CAPTAIN E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., "The History of the Indian Marine."

MARCH 8.—W. H. MORELAND, C.S.I., C.I.E., "The Report of the Royal Commission on Indian Agriculture from the Historical Standpoint."

APRIL 12.—A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

MAY 10.—P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture).

DOMINIONS AND COLONIES SECTION.

At 4.30 o'clock.

FRIDAY, DECEMBER 14.—THE RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D., "The Improvement of Negro Agriculture." DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.R.S., F.L.S., will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Ind.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." Three Lectures: January 21, 28 and February 4.

LECTURE I.—THE USE OF COAL IN ITS RAW STATE. Historical introduction—Production and distribution—Sampling and analysis—Efficiency of utilisation—Steam raising—Pulverised fuel—Furnaces and process work—Domestic heat production.

LECTURE II.—HIGH TEMPERATURE CARBONISATION PROCESSES AND COKE TREATMENT.—Gas manufacture—Purification, blending and sizing—Steaming—Oil injection—Total gasification.

LECTURE III.—LOW TEMPERATURE CARBONISATION—LIQUEFACTION OF COAL.—Low temperature carbonisation—Internal and External heating—Hydrogenation process—Synthetic processes—Combustion of oil.

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic Movements in Asia." Four Lectures: April 15, 22, 29, and May 6.

SHAW LECTURES.

Monday evenings, at 8 o'clock.

SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories 1898-1927, "Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4.

LECTURE I.—The "Looks" of the People.

LECTURE II.—Twenty-five Years' Experience of the Notification of Industrial Diseases.

LECTURE III.—Twenty Years' Experience of Compensation for Industrial Diseases.

DR. MANN JUVENILE LECTURES.

Thursday afternoons, at 3 o'clock.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, "Ships and Lighthouses." (Illustrated by lantern slides) January 3 and 10.

Special tickets are required for these lectures.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 10..Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham 7 p.m. Major C. G. Nevatt, "Experiments on Self-Energised Brakes."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.45 p.m. Mr. A. Chaston Ch "The Chemistry of Hop Oil."

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr. F. L. Brayne, "Village Uplift in India."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. E. W. Dorey, "Power Factor Tariffs and Methods of Metering."

At the University, Liverpool. 7 p.m. Mr. E. H. Shaughnessy, "Transatlantic Radio-Telephony."

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

Farmers' Club, at the Whitehall Rooms, S.W. 5 p.m. Sir William S. Haldane, "Can British Farms compete in Meat Production against Imports from Abroad."

Fuel, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Two papers on "Fuels—Alternative or Supplementary to Petrol—for use in Internal Combustion Engines for Road Vehicles"—(1) Dr. W. R. Ormandy, "Liquid Fuels" (2) Monsieur A. Métral, "Gaseous Fuels."

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Messrs. S. W. Boggs, A. R. Hinks, and others, "New Map Projections."

Heating and Ventilating Engineers, Institution of, at the Borough Polytechnic, Southwark, S.E. 7.30 p.m. Mr. E. T. Ollett, "Air Filtration."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. F. Hudson, "Scottish Moulding

Sands and their Application to Non-Ferrous Casting."
Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. F. G. Fleury, "The recent Rating Acts in Operation."
University of London, at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen. Sir Frederick Maurice, "Allenby's Campaigns in Palestine." (Lecture I).
At the Royal College of Surgeons, Lincoln's Inn Fields, W.C. 4 p.m. Mr. F. W. Twort, "The Rôle of Bacteria in Nature." (Lecture IV).
At University College, Gower Street, W.C. 5.30 p.m. Lieut.-Comdr. A. S. Elwell Sutton, "The Republic in China: Its Rise, Progress and Prospects."

TUESDAY, DECEMBER 11..Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. Mr. Harold Bowen, "Notes on Early Muhammadan Titles."
Automobile Engineers, Institution of, at the Broadgate Café, Coventry. 7.30 p.m. Major C. G. Nevatt, "Experiments on Self-Energised Brakes."
Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. W. W. E. French, "Short Circuits in Large Power Systems."
At the Engineer's Club, Manchester. 7 p.m. Mr. I. Romers, "Tariffs."
Illuminating Engineering Society, at 15, Savoy Street, Strand, W.C. 6.30 p.m. Mr. H. Lingard, "The Use of Electric Lighting for Advertising Purposes."
Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. A. H. W. Wragg, "Regions of Wine Production in France." Mr F. W. Barwick, "Under the Southern Cross from Cape Point to the Zambesi."
Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. A. Greenfield, "Practical Refrigeration for Ships."
Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Dr. A. Wade, "Madagascar and its Oil Lands."
Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. Mr. S. K. Ratcliffe, "The Impact of America on Western Civilization."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "Diamonds" (Lecture IV).
Transport, Institute of, at Hull. 7 p.m. Mr. C. E. R. Sherrington, "Latest Developments in American Railway Practice."
At the Society of Arts Hall, George Street, Edinburgh. 7.30 p.m. Dr. K. G. Fenelon, "Commercial Aviation."
University of London, at University College, Gower Street, W.C. 6.30 p.m. Mr. Percy Dunsheath, "High Tension Transmission of Power." (Lecture V).
At King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture X).

WEDNESDAY, DECEMBER 12..British Academy, at the Civil Service Commission Building, Burlington Gardens. W. 5 p.m. Prof. Dr. John Edward Lloyd. "The Welsh Chronicles." (Sir John Rhys Memorial Lecture).
Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. James Whitehouse, "Methods of Reducing Temperature in Deep Mining Work."
Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Prof. Dr. E. W. Hope, "Industrial Diseases as viewed from the Standpoint of a Medical Officer of Health."
United Service Institution, Whitehall, S.W. 3 p.m. Mr. Sadao Saburi, "Japan's Position in the Far East."
University of London, at Australia House, Strand, W.C. 6 p.m. Film Lecture concerning the Gestetner Duplicator.
At the Royal College of Surgeons, Lincoln's Inn Fields, W.C. 4 p.m. Mr. F. W. Twort. "The Rôle of Bacteria in Nature." (Lecture V).
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Linea del Paradiso." (Lecture VI).
5.30 p.m. Dr. Richard Offor, "University Library Buildings."
At the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Dragutin Subotic, "The History of Serbo-Croat and Slovene Literature in the 19th Century." (Lecture II).

THURSDAY, DECEMBER 13..Antiquaries, Society of, Burlington House, W. 8.30 p.m.
Birth Control and Racial Progress, Society for Constructive, at Essex Hall, Strand, W.C. 8 p.m. Dr. C. W. Saleeby, "Cancer Control via Birth Control Clinics."
Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Mr P. A. Spalding, "Commercial Problems relating to the Applications of Electricity from the Shannon Distribution System."
Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. V. T. Harlow, "Sir Walter Raleigh in Guiana (1617)."
Linnean Society, Burlington House, W. 5 p.m.
Mechanical Engineers, Institution of, at the South Wales Institute of Engineers, Cardiff. 6 p.m. Dr. H. W. Swift, "Power Transmission by Belts: An Investigation of Fundamentals."
At the Engineers' Club, Manchester. 7.15 p.m. Mr. William Taylor, "Science in the Workshop."
Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Mr. R. B. Deeley, "Aluminium-Silicon Alloys, their Properties and some Applications." (Joint Meeting with the Institute of British Foundrymen).
Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Dr. J. J. Fox, "Recent Analytical Methods."
Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir R. Paget, "Human Speech as a Musical Phenomenon."
University of London, at University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes as illustrating Social Life in Central and South-Western Europe from 150-750 A.D." (Lecture VII).
5.30 p.m. Prof. Dr. R. W. Seton-Watson, "A Plea for the Study of Contemporary History."
Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan. "The Sculptors of the XVIth Century."

FRIDAY, DECEMBER 14..Astronomical Society, Burlington House, W. 5 p.m.
Chemical Industry, Society of, Burlington House, W. 8 p.m. Mr. N. Swindin, "The Air-Lift as a Chemical Engineering Appliance."
Dyers and Colourists, Society of, at Manchester. Prof. F. M. Rowe and Dr. C. P. Bean, "The Effect of After-Treatments on the Degree of Aggregation and Fastness Properties of Insoluble Azo Colours on the Fibre."
Malacological Society, at University College, Gower Street, W.C. 6 p.m.
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. E. G. Herbert, "Machinability."
Metals, Institute of, at the University, Sheffield. 7.30 p.m. Mr. L. Wright, "Chromium Plating."
Oil and Colour Chemists' Association, at Milton Hall, Manchester. 7.30 p.m. Mr. R. A. Bellwood. "Present Day Methods of Oil Extraction."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Dr. Ezer Griffiths, "A Survey of Heat Conduction Problems."
Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. R. C. Reynolds, "Problems of the Future Development of Transport."
At the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Mr. H. Shaw, "Operation of the Newcastle Railway Panel."
University of London, at the University Union Society's Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "England and Bohemia." (Lecture II).

SATURDAY, DECEMBER 15..Royal Institution, 21, Albemarle Street. W. 3 p.m. Mr. Walter Bayes, "The Gulf between the Painter and the Public." (Lecture II)

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FRIDAY, DECEMBER 14th, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

DR. MANN JUVENILE LECTURES

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows:—

LECTURE I—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

INDIAN SECTION.

MONDAY, DECEMBER 3RD, 1928. SIR REGINALD A. MANT, K.C.I.E., C.S.I., Member of the Council of India, in the Chair.

A paper on "The Sugar Industry of India" was read by SIR JAMES MACKENNA, C.I.E. The paper and discussion will be published in the *Journal* on January 4th.

FIFTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 5TH, 1928. THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., in the Chair.

A paper on "Fuel for Ships" was read by SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S. The paper and discussion will be published in the *Journal* on January 11th.

REPORT ON THE COMPETITION OF INDUSTRIAL DESIGNS, 1928.*

INTRODUCTION.

The Annual Competition of Industrial Designs was held for the fifth time this year. With regard to numbers of candidates and designs there has been an increase of nearly fifty per cent. over the figures of 1927, viz., 1,024 candidates, and 3,126 designs, as compared with 745 candidates and 2,224 designs last year, and this in spite of the fact that it was found necessary to make certain additions to the entry fees.

The increase is no doubt largely due to the number and value of the prizes offered. Altogether these amounted to over £1,600, including Travelling Scholarships of £100 and £75, and a large number of prizes of £50 and under.

The Council, however, are well aware that success in a movement of this sort is to be reckoned not in quantity but in quality. Some of the work submitted was poor, but there are certain features about the present Competition which are decidedly encouraging. In the typographical sub-sections of Book Production, for instance, some admirable work was shown, and the standard of excellence, which was considered high last year, has been still further raised. In two sub-sections of Textiles the firms who had offered prizes were so pleased with the work submitted that they awarded additional prizes. No difficulty was experienced in finding suitable candidates for the two Travelling Scholarships, nor in awarding the Art Congress Studentship to the candidate who last year won the Tootal Broadhurst Lee Company's Travelling Studentship, and whose work has, in the opinion of the Judges, greatly advanced as a result of her residence abroad.

On the other hand, it must be confessed that certain sections were very disappointing. In Glass, for instance, the designs were of the poorest, many candidates appearing to be content to copy the most commonplace specimens from trade catalogues. One or two sections of Textiles were unaccountably weak

*From considerations of space it has been found necessary to omit from the Report the lists of Central and Sectional Committees, of panels of judges, and of donors of prizes and scholarships. These are however included in the separately printed Report, copies of which may be obtained on application from the Secretary, Royal Society of Arts.

though, as already mentioned, others were distinctly encouraging. The work in the Furniture Section showed, on the whole, a great improvement on that submitted last year, especially on the technical side, and in one or two sub-sections of Architectural Decoration some very promising work was submitted.

On the whole, the Council feel that they have every reason to be satisfied with the result so far achieved by the Competition. A number of young designers of originality and promise have been brought to the notice of manufacturers and have secured excellent appointments. It is not possible to quote figures in this connexion as a good many appointments have been made without being reported to the Society; but it is coming to be recognised that any competitor who makes his mark in this Competition greatly increases his chances of a successful future. Many manufacturers and publicity firms in search of designers with new ideas make a point of visiting the Exhibition every year in order to note the names and addresses of likely designers for their purpose, even though they may not have obtained prizes.

Competitors also gratefully acknowledge the help they derive from visiting the Exhibition, as it enables them to gain valuable knowledge of the requirements of manufacturers and advertisers. Fashion in design is constantly undergoing changes, and competitors are able to study the trend of public taste in design and posters and by the exercise of a little intelligent anticipation avoid sending in designs which lack originality, or are mere copies of existing productions. The exhibition of the designs also affords the general public a unique opportunity of gauging, as a whole, in London, the work done by the principal Schools of Art throughout the country.

Requests for information about the Competition were received from India, Canada, South Africa, Australia and New Zealand, and a few overseas competitors took part in this year's Competition. Distance from London is however, a serious handicap, it being impossible under present financial conditions to issue the Prospectus before January, which leaves very little time for a competitor in Australia to prepare and submit his designs for judging in July. The drawback could to some extent be overcome by announcing some of the main subjects of competition chosen for 1930 in the Prospectus issued for 1929. To enable them to do this, the Council need to re-establish a General Prize Fund, and if overseas manufacturers and trade organisations would assist the Society by contributing to the Fund so as to make it possible to announce a year in advance the offer of substantial prizes open to overseas competitors, it is evident from the interest taken in the Competition by residents in many parts of the Empire, that such offers would meet with a widespread response from competitors in the British Empire overseas.

For the benefit of those whose work is approved by the Judges for exhibition, a Bureau of Information has been opened by the Society, for the registration of the names of those exhibitors who desire to obtain employment as designers.

The information is placed at the disposal of manufacturers, and it is hoped that the Bureau will be of service both to designers and manufacturers.

The Council desire to express their appreciation of the generosity of those firms and individuals who have provided the scholarships and prizes; to the Judges who devoted much time and care to a very difficult task; to the authorities of the Imperial College of Science and Technology who provided accommodation for the reception of the designs, and to Lieut.-General Sir William Furse, K.C.B., D.S.O., Director of the Imperial Institute, through whose kindness the Society received permission to judge the designs and to hold an exhibition of selected work in the Exhibition Pavilion of the Institute.

Number of Entries.

The total number of competitors who entered for the various sections of the Competition was 1,024. Of these, 739 were students of Schools of Art, and 285 non-students.

The number (of mounts) of designs submitted was 3,126, divided as follows:—

Architectural Decoration	305
Textiles	959
Furniture	152
Book Production	206
Pottery and Glass	364
Miscellaneous	1140
Total	3,126

Reports of Judges.

James H. Hyde Travelling Scholarship.

This scholarship, of the value of £100, given by James H. Hyde, Esq., was offered for the designs showing the greatest merit in respect of invention and draughtsmanship among those submitted by candidates under 30 years of age for any of the prizes in the section of Architectural Decoration or Textiles. The scholarship was awarded, subject to the conditions stated in the Prospectus of the Competition, to:

Thomas Mitchell, Glasgow School of Architecture, whose design for a petrol-filling station won the prize in Sub-section 6 of the Architectural Section and who also sent in designs which were commended by the Judges in Sub-sections 1 and 2.

Art Congress Studentship.

The Art Congress Studentship of the value of £50, was open, under the conditions of the Competition, to any candidate in any Section (preference being given to candidates actually engaged as practising craftsmen or designers and not above the age of 28 years). The Studentship was awarded by the Judges to:

Miss Sadie Nixon, Slade School of Art, University College, Gower Street, W.C., for textile designs Nos. 3002 to 3012. These designs consist of studies executed by Miss Nixon abroad during her tenure of the Tootal Broadhurst Travelling Studentship, which was awarded to her last year, and were shown at the Exhibiton this year in accordance with the conditions of the Studentship.

SECTION I.—ARCHITECTURAL DECORATION.

SUB-SECTION 1. *Decorative Architecture. Prize of £50 offered by the Royal Society of Arts for a Design for an Entrance Hall to a Cinema.*

The Judges were unable to recommend the award of any prize, but the design submitted by

Thomas Mitchell, Glasgow School of Architecture, is Commended. (Nos. 1332 and 1333).

Mr. Mitchell should avoid pursuing the chimera of ultra-modernism. He has a decorative sense and a feeling for an *ensemble*. His work shows that he can grasp the essentials of a problem, and experience will teach him to appreciate simplicity and economy.

SUB-SECTION 2. *Prize offered by Messrs. Baguès, Ltd., for a Design for a Wrought Iron Canopy for the Main Entrance of a Popular Theatre.*

The awards are as follows :—

A Prize of £35 to John G. Sidebottom, Leeds College of Art (Nos. 1673 to 1677).

A Prize of £15 to John A. C. Howard, 90, Palmerston Road, Bowes Park, N.22. (Nos. 1279 to 1283)

Commended :

Thomas Mitchell, Glasgow School of Architecture (Nos. 1334 to 1337.)

Mr. Sidebottom's general scheme is good, but there is too little relief, and the wording does not show up sufficiently.

Mr. Howard's canopy does not afford sufficient shelter, and there is little or no artistic relation between the canopy and the standards.

Mr. Mitchell's designs are commended for originality, but the plan of the section is difficult to understand.

SUB-SECTION 3. *Lewis Berger Scholarship of the value of £60, tenable at the Royal College of Art for a period of three months for the purpose of study in Decoration and Decorative Painting.*

The awards are as follows :—

The Lewis Berger Scholarship of £60 to Henry G. Glyde, Royal College of Art. (No. 3053.)

Commended :

Alfred Garner, Stockport School of Art. (No. 3033.)

J. R. Wallace Orr, Glasgow School of Art. (No. 3087.)

Although the Judges did not care for Mr. Glyde's imitation of the primitive, and his attempt to get a modern effect from it, they felt that his sense of drawing was good, and that he would reap substantial benefit from a further course of study at the Royal College of Art. **The enlarged detail should be a completely finished section, executed in the actual colours of the coloured sketch of the full design.**

SUB-SECTION 4. *Prize offered by Messrs. Shanks & Co., Ltd., for a Design for a Bathroom in a Private Mansion.*

The awards are as follows :—

The First Prize of £31 10s. and the Second Prize of £15 15s. are divided equally between :—

Leonard S. Dixon, 7, Broadway Market, Victoria Avenue, Southend-on-Sea. (No. 1235), and

Stanley H. Smith, 240, Lavender Hill, Enfield, Middlesex. (Nos. 1424 and 1425.)

Highly Commended :

William Leslie Nicholson, L.C.C. School of Building, Brixton, S.W. (No. 1020.)

Design No. 1424 shews an excellent arrangement of the Sanitary Appliances in relation to the outside wall. It would probably be an advantage to have a door to give communication between the W.C. Compartment and the Bidet.

In design No. 1235, the bath is placed in a recess which would not get much daylight. It would be an improvement to have the Bidet where the lavatory basin is placed so as to bring the Bidet nearer to the W.C.

Design No. 1020 is highly commended. It is simple and direct. There is no need, however, for a step in front of the bath. This would be found objectionable in use.

The designs submitted shew, generally, a lack of originality. For convenience in use the hot water towel rail should be near the bath and the Bidet should be readily accessible from the W.C. These considerations were frequently overlooked Rounded angles between walls and floors were frequently omitted.

SUB-SECTION 5. *Prize offered by A. J. Davis, Esq., F.R.I.B.A., for Design for a a Decorative Fountain.*

The awards are as follows :—

The Prize of £15 is divided equally between :—

John N. Summerson, 61, Belsize Avenue, N.W.3. (No. 415.)

Raymond M. Walker, Leeds College of Art. (No. 1678.)

The Judges were disappointed to find that more architects did not compete in this Sub-Section, the designs submitted being generally very poor. The Prize has been award d conjointly to the competitors whose schemes most nearly satisfy the conditions.

SUB-SECTION 6. *Prize offered by Murray Adams-Acton, Esq., for a Design for a Petrol-Filling Station.*

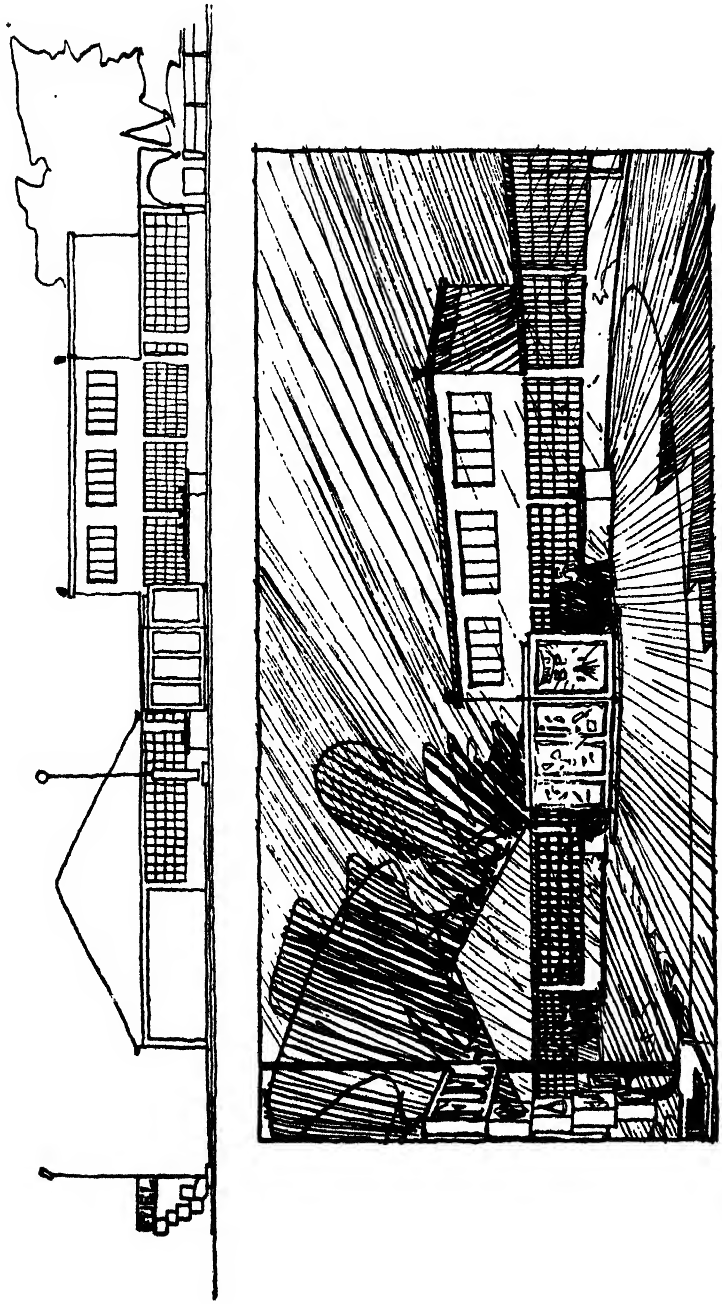
The awards are as follows :—

A Prize of £25 to Thomas Mitchell, Glasgow School of Architecture. (No. 1339.)

Commended :

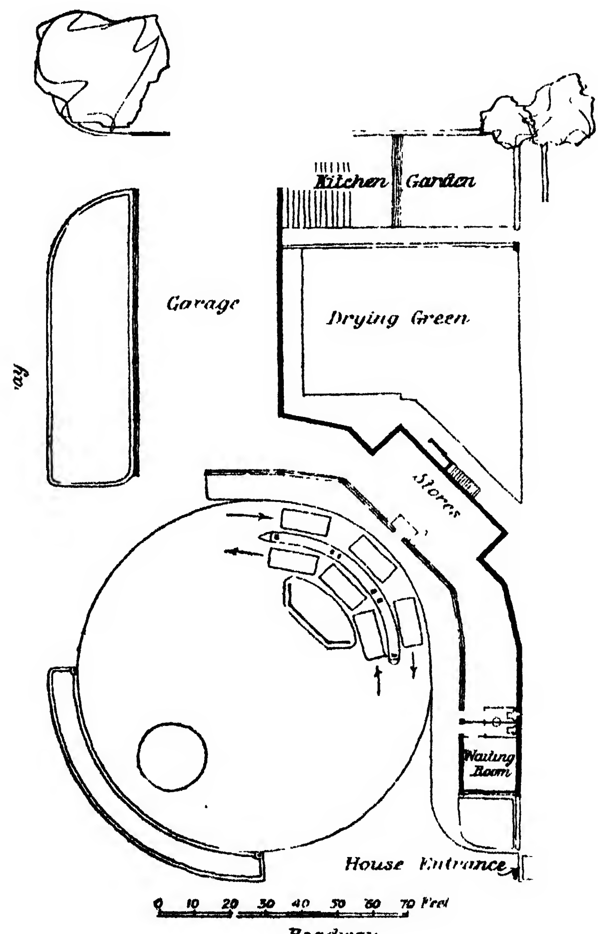
Robert J. H. Minty, A.R.I.B.A., A.M.I.Struct.E., 21, Great Peter Street, S.W.1. (Nos. 1004 and 1005.)

Among the designs for Petrol-Filling Stations, that of Mr. Mitchell (Glasgow School of Architecture), was considered to fulfil the conditions most satisfactorily, the prime reason being that the plan is reasonable and shows easy means of ingress



Elevation of Design by Thomas Mitchell for a Petrol Filling Station.

and egress to the pumps. A dual function is served by the posters which screen the pumps. The buildings are simple in character and capable of economic erection, while a further merit lies in the fact that the scheme can be developed to serve increasing needs. Mr. Minty's design is the best of the designs schemed on ordinary lines where the pumps are displayed.



Plan of Design by Thomas Mitchell for a Petrol-filling Station.

SUB-SECTION 7. *Prize of £25 offered by the Royal Society of Arts for a Design for a Silver Cup for the Swiney Prize for the best published work on Jurisprudence.*

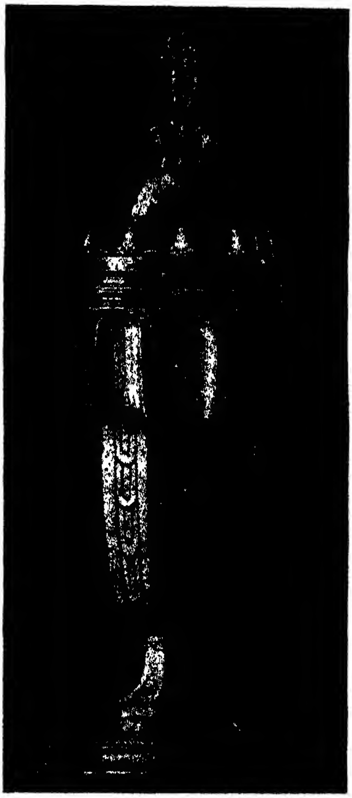
The awards are as follows :—

A Prize of £25 to Edward N. H. Spencer, 4, Conduit Street, W.1. (No. 1427.)

Highly Commended :

Miss Mary H. Rowlinson, Manchester Municipal School of Art. (No. 2776.)
Edward N. H. Spencer, 4, Conduit Street, W.1. (No. 1426.)

No. 1427 undoubtedly stands out for originality. Proportions, outline, and detail are all very good. Possibly the sort of scale decoration might be aggressive in the drawing, but no doubt this could be subdued in the execution. No. 1426 is of very good outline and proportion. No. 2776 is also of very good outline and proportion, and shows great promise. The foot however is rather short.



Design for a Silver Cup by Edward N. H. Spencer.

SECTION II.—TEXTILES.

SUB-SECTION 1. *A set of at least four designs for printed dress goods; a set of at least four designs for printed furnishings; and a set of at least four designs for woven dress goods. A Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company, Ltd.*

The Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company, Ltd., and an Owen Jones Medal, are awarded to Miss Barbara Lebkuchen, Slade School of Art, University College, Gower Street, W.C., (Nos. 372 to 383.)

The following awards are also made :—

A Royal Society of Arts Prize of £5 to Miss Betty M. Heesom, L.C.C. Central School of Arts and Crafts. (Nos. 923 to 930, 932, 934 and 935.)

A Royal Society of Arts Prize of £3 to Miss Angela Bradshaw, Manchester Municipal School of Art. (Nos. 2696, 2698, 2699 and 2750.)

A large number of designs were submitted, but the standard was not so encouraging as last year. In one or two notable cases the designer seems less accomplished than before. Miss Barbara Lebkuchen, however, sent in a charming set of designs, which are extremely well carried out and eminently practical. Miss Betty M. Heesom also shows considerable originality, as does Miss Angela Bradshaw. In these two cases more care in execution and more attention to practical points would have much improved their exhibits. Extravagance in design is not necessarily originality and ingenious simplicity is not sufficiently considered. Further, fine taste in colour is wanted rather than multiplicity of colours in one scheme, and several designs, good in form, suffered from poor distribution and choice of colour.

The Judges are pleased to note that last year's winner of the Studentship, Miss Sadie Nixon, has distinctly profited by the opportunity afforded her. Her set of designs may be recommended to this year's competitors as showing care in execution combined with originality of subject.

SUB-SECTION 2. *Designs for Cretonne based on any floral subject other than the rose. Prizes offered by Messrs. Simpson & Godlee, Ltd*

The awards are as follows :

The First Prize of £52 10s. to Granville Hannah, 78, Rochdale Road, Middleton, Manchester. (No. 949.)

The Second Prize of £31 10s. to Miss Margaret H. McColl, 9, Sherbrooke Avenue, Pollokshields, Glasgow, S.1. (No. 617.)

The Third Prize of £21 to Henry C. Whaite, L.C.C. Central School of Arts and Crafts. (No. 722.)

A Special Prize of £15 15s. to Miss Janet McIntyre Guthrie, Royal Technical College, Glasgow. (No. 1260.)

A Royal Society of Arts Prize of £10 10s. to Miss Margaret Crees, Swindon School of Art. (No. 1864.)

The entries in this section were numerous and well up to, but not above, the standard of previous years. Many of the designs submitted were weak in colour and not original in conception. On the other hand, several designs showed considerable originality in composition and in colour scheme. The design awarded a *special prize* of £15 15s. is distinctly original, but suffers from insufficient care in drawing and execution. Competitors should be advised to take more care in this, the practical side of the question of designing for reproduction in cretonnes.

The three prize-winning designs are all good in treatment and in choice of subject and also practical. The first prize design is, undoubtedly, the best. The design recommended for a Royal Society of Arts prize is original in conception, but perhaps hardly so suitable for reproduction as the others. On the whole, the competitors are to be congratulated on a good exhibition of useful designs.

SUB-SECTION 3. *Designs suitable for printing by block on 30in. width of cloth, each design to be accompanied by five different colour scheme suggestions. Prizes offered by Messrs. G. P. & J. Baker, Ltd.*

On examining the work submitted, Mr. G. P. Baker decided to increase the amount of the prize money so as to allow for a first prize of 20 guineas, two prizes of 15 guineas each, and one prize of 10 guineas.

The awards are as follows :—

The First Prize of £21 to Miss Vera M. Moller, Royal College of Art (Nos. 618 to 622.)

A Prize of £15 15s. to each of the following :—

Miss Nancy Hallworth, Manchester Municipal School of Art. (No. 2714.)

Miss E. Lawrence, Manchester Municipal School of Art. (No. 2739.)

A Prize of £10 10s. to Miss Doris K. Taylor, Liverpool School of Art. (Nos. 2884 and 2885.)

The design winning the first prize is original in conception, and well in harmony with modern taste. While very fine in its lines, it is adapted for direct printing by block on tinted grounds, and for dark-coloured ground it can be made adaptable for discharge printing by machinery or by block.

Design No. 2714 is very practically drawn, the effect being produced with only a small amount of detail. The complete design shows the best colouring scheme of all the works submitted for this competition. There is also considerable merit in the composition of design No. 2739. The furrows of the ploughed field are too much emphasized, and, especially in some schemes of colouring, there would have to be some modification in order to obviate a blemish. Design No. 2884 is simple, well-drawn, highly-finished and thoroughly practical. It shews much consideration for the method by which it is to be produced, and the effect is decidedly good. Some of the colour schemes in this set were of considerable merit. One could recommend such a design for hangings in most rooms with ordinary decoration.

Students of design must remember that a fabric with very extravagant ornament often necessitates the scrapping of furniture in order to keep the whole scheme in harmony

The Judges consider that the works exhibited in this small class are generally creditable, and that an improvement is distinctly noticeable when a comparison is made with the general standard of former years.

SUB-SECTION 4. (*a*) *Design in the " modern " style suitable for a printed cotton or linen fabric for use in house furnishing*

(*b*) *Design in the " modern " style suitable for a printed tapestry or moquette for use in furniture covering. Prizes offered by Messrs. Arthur H. Lee & Sons, Ltd.*

The awards in Sub-Section 4 (*a*) are as follows :—

The First Prize of £20 to Thomas J. Corbin, Royal College of Art (Nos. 1201 and 1202.)

The Second Prize of £10 to Miss Mary D. Cooper, Royal College of Art. (No. 2628.)

Highly Commended :

Miss Phyllis Donaldson, Royal College of Art. (No. 1522.)

Miss G. Gervis, L.C.C. Central School of Arts and Crafts. (No. 889.)

Miss K. Bernice Williams, Manchester Municipal School of Art. (No. 2804.)

Commended :

Miss Evelyn G. Widdop, Manchester Municipal School of Art. (No. 2800.)

The awards in Sub-section 4 (*b*) are as follows :—

The First Prize of £20 to Miss Phyllis Donaldson, Royal College of Art. (Nos. 1524 and 1525.)

The Second Prize of £10 to Miss Mary D. Cooper, Royal College of Art. (No. 2630.)

Highly Commended :

Miss Barbara Heath, 194, Greenvale Road, Eltham Park, S.E.9. (No. 1271.)

Miss Violeta E. D. Janes, Watford School of Art. (No. 1910.)

Miss Olive Nash, Reading University School of Art. (No. 1364.)

The Judges find that a great many of the competitors have failed to comply with the conditions under which the prizes were offered.

Failures in this respect fall mainly under two heads :—

(1) The ignoring by some of the competitors of the fact that designs in the "Modern" style were required, and (2) the failure of the very large majority of the competitors to display their designs for tapestry or moquette in "colourings appropriate to the fabric and purpose for which it is intended."

The colourings of these designs in nearly every case were far too thin to give the colour-effect of fabrics such as Tapestry or Moquette. Competitors have obviously been thinking of producing a prize-winning sketch (or, in some cases, of submitting old designs that they already had on hand, with which they thought they might get a prize), instead of visualising a beautiful fabric of which their sketch was intended to illustrate the design and colour.

The designs for printed linen and cotton fabrics were, on the whole, more satisfactory both as regards design and colour.

Design No. 2800 was felt to call for special comment on account of its charm and the happy inventiveness displayed; at the same time, the scenic treatment renders it less generally practical, though for nursery decoration, for instance, it might be altogether delightful.

Sub-Section 5. *Design for an eight-colour Jacobean Block for 50in. Linen. Prizes offered by Messrs. Story & Co., Ltd.*

The awards are as follows :—

The First Prize of £15 15s. to Miss Ida M. Dight, Brackley, Crofton Lane, Orpington, Kent. (No. 1236.)

The Second Prize of £10 10s. to Mrs. Marjorie Reynolds, The Knightons, 112, Gordon Road, Camberley, Surrey. (No. 1502.)

Although the design winning the first prize (No. 1236) is plainly based on a well-known Jacobean embroidery, it shows originality in treatment without departing from the characteristics of English design in the 17th century. The design is well conceived and skilfully adapted to the style. The colouring is pleasant, but it will require reinforcing to some extent when reproduced. The second prize is awarded to No. 1502. The design is, perhaps, thin and in this respect it cannot be compared with No. 1236. The colouring perhaps errs in the opposite direction to that example, and there is a suggestion of harshness which needs some modification.

Several other works sent in have shown a real knowledge of the style on which the designs were to be based, but some have not, and the Judges would impress upon students the advisability of making themselves well acquainted with historical styles.

SUB-SECTION 6. *Designs suitable for printing on 50in. linen for use as draperies or furnishings, based on any English period style of decoration. Prizes offered by Messrs. F. W. Grafton & Co., Ltd.*

The awards are as follows :—

The First Prize of £30 to Miss Edith L. V. Ailsby, 45, Seagrave Road, Fulham, S.W.6. (No. 1185.)

The Second Prize of £15 to Miss Winifred Orde-Ward, L.C.C. Central School of Arts and Crafts. (No. 418.)

The Judges are disappointed with the number of entries, which was only nine in all. Generally speaking, the designs submitted are not particularly outstanding. Miss Edith Ailsby's "Flowers in Basket" design stands out, and is distinctly good. Also Miss W. Orde-Ward's is quite clever and original. Apart from these there is nothing very new.

SUB-SECTION 7. *Designs for Silk Fabrics for Furniture and Decoration in which one or more shuttles are used. Prizes offered by Messrs. Warner & Sons.*

No awards were made in this Sub-Section.

SUB-SECTION 8. *Design for an Axminster Carpet suitable for a Drawing Room. Prize offered by Messrs. John Crossley & Sons, Ltd.*

The Judges were unable to recommend that the full prize should be given, but the following awards were made :—

A Prize of £15 to Miss Barbara Lebkuchen, Slade School of Art, Gower Street, W.C., for her two designs. (Nos. 384 and 385.)

A Prize of £5 to Walter Shepherd, Kidderminster School of Art. (Nos. 1090 and 1091.)

Commended :

G. I. Foreman, 11, Westgate, Halifax, Yorks. (Nos. 68 and 69.)

Frank Heaton, 68, Bacup Road, Todmorden. (Nos. 98 and 99.)

This class on the whole was poor, and, with the exception of Miss Lebkuchen's designs, there was an absence of originality. No design was considered by the Judges worthy of the £30 prize offered.

SUB-SECTION 9. *Two Designs suitable for Axminster Carpets for a Lounge. Prizes offered by Messrs. Tomkinsons, Ltd.*

The awards are as follows :—

The First Prize of £20 to Cyril Astle, Grand View P.O., Brantford, Ontario, Canada. (Nos. 1175 and 1176.)

The Second Prize of £10 to Miss Margaret E. Hays, The Mythe, Neville Road, Bognor, Sussex. (Nos. 550, 551 and 553.)

Highly Commended :

Frederick E. R. Everley, Kidderminster School of Art. (Nos. 1735, 1736 and 1737.)

This class contained many designs of interest and originality. The first prize designs were marked by good conception of form and well executed draftsmanship. The designs of Miss Hays, who won the second prize, possessed novelty and freshness, particularly No. 551, which contained an idea that could be developed with pleasing effect.

SUB-SECTION 10. *Prizes offered by Messrs. A. Herbert Woolley & Co., Ltd., for (a) design for a Lace Flounce not less than 27in. wide in Artificial Silk and Silk, for dyeing in two colours, and (b) a set of designs for Lace suitable for trimming Ladies' Underclothing, comprising 2in. Lace; 2in. Insertion; 4in. Lace; 6in. Novel shape made intersecting so as to get two shapes in the 6in. width, with outer edges that would not require scalloping.*

The awards in 10 (*a*) are as follows:—

A Prize of £7 to Miss Winifred E. Bexton, Nottingham School of Art. (No. 2914.)
A Prize of £5 to Miss Maud L. Cass, Nottingham School of Art. (No. 2932.)
A Prize of £3 to Geoffrey R. Dearden, Nottingham School of Art. (No. 2942.)

The award in 10 (*b*) is as follows:—

A Prize of £5 to Miss Winifred E. Bexton, Nottingham School of Art. (No. 2915.)

There was an encouraging improvement in the number and quality of the designs for flounces, though the designs for laces were not only few in number, but, with one exception, of little merit. The flounce design to which the first prize was awarded was of special merit owing to the excellent balance of the two colour effects, though different colours to those shewn in the design would be actually used by the manufacturer.

SUB-SECTION 11 *Designs for a set of four panels of hand embroidery. Prize offered by Mrs. Lewis F. Day.*

The awards are as follows:—

A First Prize of £10 to Miss Nancy Guest, Manchester Municipal School of Art. (No. 2713.)
A Second (Royal Society of Arts) Prize of £5 to Miss Winifred R. Simmonds, Royal College of Art. (No. 1563.)
A Third (Royal Society of Arts) Prize of £2 to Miss Gladys A. Brailsford, Battersea Polytechnic School of Arts and Crafts. (Nos. 2258 and 2259.)

Commended:

Miss Ethel Nettleship, 46, Powis Square, W.11. (No. 397.)

The designs for this competition were, for the most part, rather disappointing, as showing little originality. There was also too great a tendency to what might be called the "Sale of Work" class of embroidery. Some designers had not indicated the colours, and others submitted designs which were too pictorial or otherwise ill-calculated to be reproduced in needlework. The winning design shows an original treatment in colour and composition of pictorial subjects, and is well adapted for embroidery. The second and third designs are also original in subject and treatment but perhaps not quite so suitable for immediate rendering in needlework. Designers of embroidery patterns should bear in mind that apart from originality and good composition, colour and stitch should also be considered and indicated.

SUB-SECTION 12. *Design for Wallpaper suitable for either a living room or a bed-room. Prize offered by the Wallpaper Manufacturers, Ltd.*

The awards are as follows :—

A Prize of £10 10s. to Victor R. Brown, L.C.C. Hammersmith School of Arts and Crafts. (No. 211.)

Highly Commended :

Miss Eileen Langmead, "Hamont," Goodwyn Avenue, Mill Hill, N.W.7. (No. 1312.)

Commended :

Victor R. Brown, L.C.C. Hammersmith School of Arts and Crafts. (Nos. 208, 209 and 210.)

The wallpaper designs numbered less than 40, and of these the drawings of Victor R. Brown, of the Hammersmith School of Art, were outstanding, both from the point of view of their practicability and commercial value.

The design of Miss Langmead shewed vision and is highly commended. Of the rest, there was little which could be considered praiseworthy, or which shewed much intelligent guidance in the training of the students.

SUB SECTION 13. *Additional Prizes offered by Messrs. Turnbull & Stockdale, Ltd., for the two most original designs intended for Cretonne or hand block printing, which, whilst showing suitability to material and use, shall be judged mainly for their imaginative and aesthetic qualities. The Prizes were open to students or designers serving apprenticeship in studios or drawing offices, not over 21 years of age on December 31st, 1927. Entries in Sub-sections 1, 2, 3, 4, 5 and 6, provided the competitor complied with the above regulation, were eligible for these additional Prizes.*

The awards are as follows :—

The First Prize of £15 to Miss Mollie A. Maylam, Regent Street Polytechnic School of Art. (No. 1356.)

The Second Prize of £10 to Miss Violeta D. E. James, Watford School of Art. (No. 1910, entered for Sub-section 4 (*b*)).

Highly Commended :

Thomas J. Corbin, Royal College of Art. (No. 1202, entered for Sub-section 4 (*a*)).

Miss G. M. Dickinson, L.C.C. Hammersmith School of Arts and Crafts. (No. 2071.)

The two first designs were awarded prizes on the grounds of their imaginative and aesthetic qualities, combined with simplicity of treatment and suitability for their purpose.

The designs submitted in this sub-section were, on the whole, fair, with three or four exceptions. Generally they did not shew a very good colour sense. Colour harmony should be studied to a greater extent in Schools of Art than at present seems to be the case.

SECTION III.—FURNITURE.

The Competition in Furniture attracted a very considerable number of designs in the various sub-sections, which may be divided roughly into three categories :—

(*a*) The frankly pedestrian drawing in which the details of some historical style have been embodied in a more or less uninspired composition.

(*b*) Designs evidently influenced by a modern mode of expression in the furniture trade and showing traces of a half-assimilated continental conception of design.

(*c*) Designs submitted by students who have conceived of their task as necessitating originality, and expressing too great a regard for novelty for the sake of novelty.

SUB-SECTION 1. *Prize offered for Furniture for a Dining-Room.*

The awards are as follows :—

A First Prize of £20 to Robert Balfour Graham, Barnstaple School of Art. (No. 142.)

A Second Prize of £5 to William H. Russell, c/o Mr. W. Stanley, Leamington Road, Broadway, Worcs. (Nos. 1547 and 1548.)

Highly Commended ·

James Watson, 13, Albany Road, West Twerton, Bath. (No. 324.)

Cyril L. White, Nottingham School of Art. (Nos. 2977, 2978, 2979 and 2980.)

The first prize (No. 142), was allotted to a scheme in silky oak inlaid with laurel wood. The Judges hesitated in giving this first place on account of the questionable construction of the chair backs, but were impressed by the general proportions and workman-like expression.

The design awarded second prize (No. 1547), is a design of an entirely different character which is approached from the point of view of the cabinet maker rather than the mere drawing board designer. It can hardly be doubted that this drawing is made by a man who has either worked at the bench or has been closely associated with workshop conditions. It is a design which is evolved from cabinet making and chair making experience. Here is a design which is new, but nevertheless soundly English in its conception. There has been no coquetry with Parisian novelties.

Mr. James Watson (No. 324), easily takes first place as a water colour artist in portraying furniture, but the facility and skill with which he can make an extraordinarily pleasing group occasionally leads him into defects as far as construction is concerned. Mr. Cyril White's scheme (Nos. 2977-2980), for a dining room was very favourably commented on by the Judges, and he probably lost the first or second place on account of the rather startling glazing of his cabinet, and it was not entirely clear what would be the purpose of this cabinet in a dining room.

SUB-SECTION 2. *Prizes offered for Furniture for a Drawing-Room.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £5 to each of the following .

Duncan McC. Grassie, 14, Blythswood Terrace, Sandy Road, Renfrew. (No. 907.)

Douglas L. Hadden, Wycombe Technical Institute, High Wycombe. (No. 1685.)

A Prize of £3 3s. to John A. L. Hill, L.C.C. Central School of Arts and Crafts. (Nos. 534 and 535.)

This sub-section was weakest both in the number of designs submitted and their quality. This may be attributable to the passing of the drawing room and the coming of the more intimate furnishing of the sitting room.

Mr. D. McCallum Grassie's set of drawings are conventional, and rather uninspired ; the line of the cabriole legs in his design (No. 1907), is exaggerated and open to question. Mr. J. A. L. Hill sent in a distinctly modern design (No. 534-5), and it would pay him to take a little time to present his designs in a more attractive manner.

SUB-SECTION 3. *Prizes offered by the London Cabinet and Upholstery Trades Federation, for Designs for a Best Bedroom Suite in the Modern Style.*

The Judges were unable to recommend that the full amount of the First Prize should be awarded to one competitor. They accordingly decided to pool the amount available for the first and second prize, and to make the following awards:—

A Prize of £7 10s. to each of the following :

Frederick W. de la Mare, L.C.C. Brixton School of Building. (Nos. 961 and 962.)

Cyril L. White, Nottingham School of Art. (Nos. 2974, 2975 and 2976.)

An Owen Jones Medal is also awarded to Cyril L. White. (Nos. 2974 to 2976.)

A Prize of £5 to each of the following :

Donald Williamson, Sheffield College of Arts and Crafts. (No. 2159.)

James Watson, 13, Albany Road, West Twerton, Bath. (Nos. 326 and 327.)

Highly Commended :

John A. L. Hill, L.C.C. Central School of Arts and Crafts. (Nos. 536 and 537.)

Commended :

Alwyn G. Allen, Mr. J. H. Roberts' Studio, 30, Royal Crescent, W.11. (No. 1177.)

Frederick C. Gilray, Edinburgh College of Art. (Nos. 2650 and 2651.)

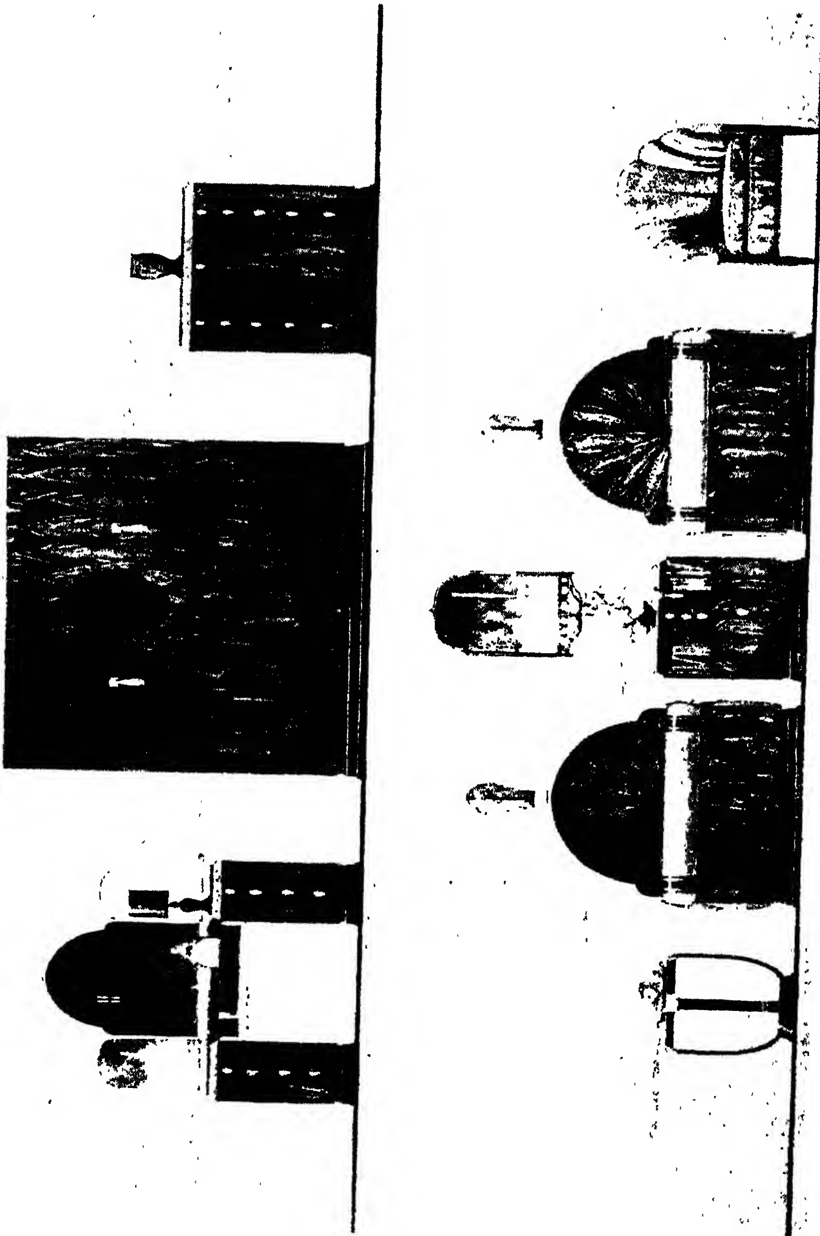
Duncan McC. Grassie, 14, Blythswood Terrace, Sandy Road, Renfrew. (No. 908.)

This sub-section attracted by far the greatest number of designs. The Judges had very little difficulty in at once rejecting a great number of them. The conditions in this sub-section were that the designs should be distinctly original, and many of the competitors had lost sight of this. It is not sufficient in a competition where originality is demanded to make slight variations in designs which can be seen in the show windows of any large retail furnishing establishments. There were four schemes of outstanding merit submitted, the first and second places being given respectively to Mr. F. W. De la mare, a competitor whose work has been successful in former Competitions, and Mr. C. L. White, for a design in which originality was tempered by restraint. The third place was gained by Mr. Donald Williamson, who is evidently at some variance with Hogarth, for there is not a curved line anywhere in his scheme. This dependence on angularity has not betrayed him into undue harshness, because he is saved by an intrinsic sense of proportion. Mr. James Watson, in his Bedroom Furniture, as in some of the other designs which he submits, is too apt to think of wood in terms of marble, but his draughtsmanship and the general presentation is admirable.

SUB-SECTION 4. *Prize offered for Design for Two Sets of Dining-Room Chairs.*

The award is as follows :—

A Prize of £5 5s. to Sydney J. Stokes, Regent Street Polytechnic School of Art. (Nos. 1060 and 1061.)



* Design by Frederick W. de la Mare for a best bedroom suite in modern style.

* Reproduced by kind permission of *The Cabinet Maker*.

* Design by Cyril L. White, for a best bedroom suite in modern style the elevation above showing the two beds with pedestal cupboards.

* Reproduced by kind permission of *The Cabinet Maker*.

SUB-SECTION 5. *Prize offered by the "Cabinet Maker" for a design for a Cabinet for a Wireless Receiving Set.*

The awards are as follows :—

A Prize of £5 5s. to William F. Payne, Bath School of Art. (No. 1036.)

Highly Commended :

William F. Payne, Bath School of Art. (No. 1038.)

In this Sub-Section a number of designs were submitted, some of them frankly disguises and others unhappy mixtures. The problem of designing a wireless cabinet had not been approached with the clarity of intention which would have made it possible to incorporate the apparatus in the design in an agreeable manner, and the feeling of the necessity for disguise predominated. The prize-winning design by Mr. William F. Payne, was the nearest approach to a new piece of furniture, new in intention as well as in form ; and another design by the same competitor was highly commended also, for it showed a grasp of the fundamental problem presented.

SUB-SECTION 6. *Prize offered by the Star Manufacturing Company for a set of six Designs for Decoration of Side Panels of Baby Carriages.*

The award is as follows :—

A Prize of £10 to Miss Honor Howard-Mercer, Guildford School of Art. (No. 980.)

The entries were only few in number, doubtless owing to the subject being new. Two of the designs are not suitable for the purpose in view, though they could be applied to other trades, and are quite good in themselves.

The third entry (No. 980), shows a grasp of the subject from a utility as well as artistic standpoint, and this secures the prize offered.

If the subject were developed more on these lines in subsequent Competitions, there would be more scope for prize-giving.

SECTION IV.—BOOK PRODUCTION.

SUB-SECTION 1. *A Title-page set from type, with or without printers' ornaments.* [The book prescribed in each Sub-Section was "Westward Ho!" (Crown Quarto).]

The awards are as follows :—

A Prize of £4 4s. to David C. Shand, London School of Printing & Kindred Trades. (No. 1411.)

A Prize of £3 3s. to each of the following :—

John F. Adams, London School of Printing & Kindred Trades. (No. 1785.)
Herbert G. Newman, London School of Printing & Kindred Trades. (No. 1342.)

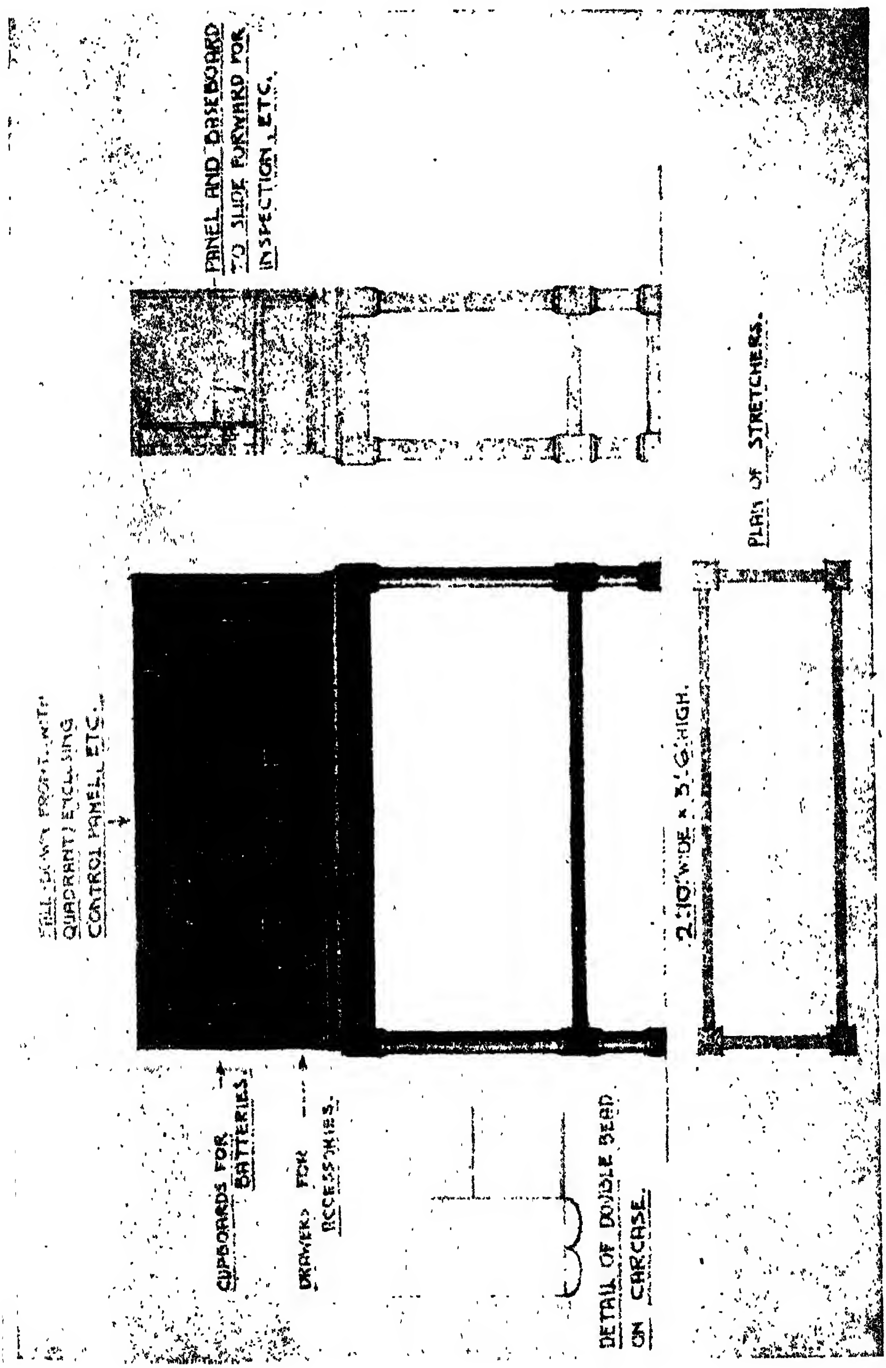
Highly Commended :

William H. G. Adams, London School of Printing & Kindred Trades. (Nos. 1179 and 1182.)

E. Thurston Lewis, London School of Printing & Kindred Trades. (No. 1299.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1413.)

Commended :

Peter Carruthers, 6, Hughenden Road, Horfield, Bristol. (Nos. 499 and 502.)



* Design by William F. Payne to be executed in walnut for a cabinet for a wireless receiving set.
Reproduced by kind permission of *The Cabinet Maker.*

SUB-SECTION 2. *A Contents page, set from type.*

The awards are as follows :—

A Prize of £6 6s. and a Prize of £4 4s., to George L. Riddell, London School of Printing & Kindred Trades, for Nos. 1779 and 1778 respectively.

An Owen Jones Medal is also awarded to George L. Riddell. (Nos. 1779 and 1778.)

Highly Commended :

Francis Doherty, London School of Printing & Kindred Trades. (No. 1222.)
George L. Riddell, London School of Printing & Kindred Trades. (No. 1777.)

Commended :

Alfred J. Bouch, London School of Printing & Kindred Trades. (No. 1770.)
Frederick C. Errington, Camberwell School of Arts & Crafts. (No. 1577.)

SUB-SECTION 3. *Three pages of text, set from type.*

The awards are as follows :—

A Prize of £4 4s. to George L. Riddell, London School of Printing & Kindred Trades. (No. 1772.)

A Prize of £3 3s. to each of the following :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1774.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1415.)

Highly Commended :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1773.)
David C. Shand, London School of Printing & Kindred Trades. (No. 1416.)

Commended :

George L. Riddell, London School of Printing & Kindred Trades. (No. 1775.)

The Judges are impressed with the increasing interest taken in Sub-Sections 1, 2 and 3. Every year shows an increase in the number of entries, and what is more pleasing, a higher standard of craftsmanship. The section representing the contents page and text matter is worthy of special attention. Many specimens submitted showed original ideas of treatment, and a high standard of technique. Great difficulty was found in adjudicating these sections.

It was rather disappointing to find a number of exhibits which could not in any way be interpreted as title pages. They were more in the nature of a commercial circular, printed in two or three colours. Those entering for these Competitions should make a study of title pages of a good standard.

There seems to be a general tendency to view the Competitions from the point of view of what is required in the publication of " special editions." Competitors should bear in mind the character of the book which they are producing. " Westward Ho ! " is essentially what may be called an ordinary or common novel, but only one competitor seemed to have had this point in view. In the contents pages some good examples were shown, but competitors should bear in mind the purpose of a contents page, which in all instances should be legible in its design and composition.

Some specimens were quite unsuitable for exhibition, and the notice of the competitors should be drawn to the rules of the Competition. In certain instances lay-outs were submitted, and others with hand work introduced. Such are ineligible. Further, it is not desirable that the same setting with an initial in a different colour should be submitted as a separate entry.

Competitors should understand the purpose of the Competition, which is for the improvement of book production. Originality of treatment is the main consideration. Many excellent examples were submitted, but frequently they were copies of well-known publications.

SUB-SECTION 4. *Drawings in black and not more than two tints of (a) a head-piece: (b) tail-piece; (c) thumb-nail illustration, suitable to the size of the page.*

No awards were made in this Sub-Section.

Any head-piece or tail-piece must, above all things, be of a suitable weight for the type to produce a well-balanced page. All designs in future should be submitted with the type as a complete page or opening.

The Judges regret that no competitor has realised either the limitations or the possibilities of this section of the Competition, and they can make no awards nor recommend that any of the designs should be exhibited.

SUB-SECTION 5. *A case for a binding in either cloth or leather.*

The awards are as follows :—

A Prize of £2 2s. to Donald Bosher, Leicester College of Arts & Crafts. (No. 1753.)

Commended :

Charles Clifford Mitchell, Leicester College of Arts & Crafts. (No. 1752.)

Several candidates submitted designs for sides without backs as well. This should never be done, as sides and back form a complete whole.

"Leather working," although possibly suitable for blotters, is quite unsuitable for any practical form of book-binding.

The designs submitted were on the whole far too ornate, and most of them were unsuitable.

SUB-SECTION 6. *Designs for End-papers.*

The awards are as follows :—

A Prize of £6 6s. to Miss Katie McDonald, L.C.C. Central School of Arts & Crafts. (Nos. 2652 and 2653.)

A Prize of £3 3s. to Miss Joyce E. Gregory, Hornsey School of Art. (No. 2171.

Commended :

Miss Bertha J. Olyett, Press Art School, Forest Hill, S.E. (Nos. 1550 and 1551.

End-papers are used to join the cover and the text, and therefore should neither be obtrusive nor expensive to produce. It is advisable that they should not be pictorial and certainly not cut in half by the joint. The design by Miss Vera F. Fox (No. 2841) is a good drawing in this misdirection.

The wood-engraved end-papers (Nos. 2652 and 2653) are the most original submitted; they are well drawn and suitable for their purpose. The second prize of £3 3s. is awarded to No. 2171, mainly for the wood-engraved design 3.

SUB-SECTION 7. *Designs for a Jacket.*

The awards are as follows :—

A Prize of £6 6s. to Miss Olive Francis Harris, Royal College of Art. (No. 524.)

A Prize of £3 3s. to Miss Doris Gully, Battersea Polytechnic School of Arts & Crafts. (No. 2271.)

Highly Commended :

Miss Daphne V. Barry, Battersea Polytechnic School of Arts & Crafts. (No. 2257.)

Miss Joyce Hall, Royal Albert Memorial School of Art, Exeter. (No. 555.)

Miss Katie McDonald, L.C.C. Central School of Arts & Crafts. (No. 2654.)

Commended :

Miss Margaret Blundell, Liverpool School of Art. (No. 2820.)

Miss Joyce H. Davies, Liverpool School of Art. (No. 2831.)

Miss Margaret E. Frere, Battersea Polytechnic School of Arts & Crafts. (No. 2267.)

William A. Wright, Battersea Polytechnic School of Arts & Crafts. (No. 2289.)

The Judges desire to point out that an essential part of the design of a book jacket is the title, etc. Many of the designs submitted avoided this important and difficult problem. Several, good as drawings, were rejected on the ground of unsuitability, while many were too expensive to reproduce. One design by Miss Gwendolen Jones (No. 2416) was more suitable for an end-paper and was accordingly transferred to that Sub-Section. Nos. 1559 and 1560 would make good window bills, but would be too expensive for book jackets.

SECTION V.—POTTERY AND GLASS.

A large number of designs for China and Earthenware were sent in, showing on the whole a good technical knowledge and generally a high standard of artistic taste. Unfortunately, the limits of space did not permit a large number to be exhibited so that it was necessary to set a rather high standard in making the awards, and in selecting designs for exhibition, and many designs had to be rejected for only minor faults.

Competitors from districts outside the Potteries area were obviously handicapped by their fewer chances of obtaining technical knowledge, and the Judges recommend to them a closer study of what is required in small essential details, such as thickness of handles on cups, size of foot to obtain a good stand, and adequate knobs on covers. These points can easily be observed on pottery in their own homes or in shop windows.

To those competitors from the Junior Department of the Burslem School of Art, we should like to offer words of encouragement. Their work is bright and shows distinct promise for the future.

SUB-SECTION 1. (CHINA). *Design for a Cup and Saucer, Cream, and Bread and Butter Plate, with suitable decoration.*

The awards are as follows:—

A Prize of £5 5s. to each of the following :

Miss Catherine M. Brown, Watford School of Art. (No. 1898.)

William Ruscoe, Stoke Art School. (No. 1372.)

Commended :

Mrs. Inez Batterbury, Blackheath School of Art. (No. 342.)

Miss Freda M. Beardmore, Burslem Art School (Junior Dept.) (No. 2467.

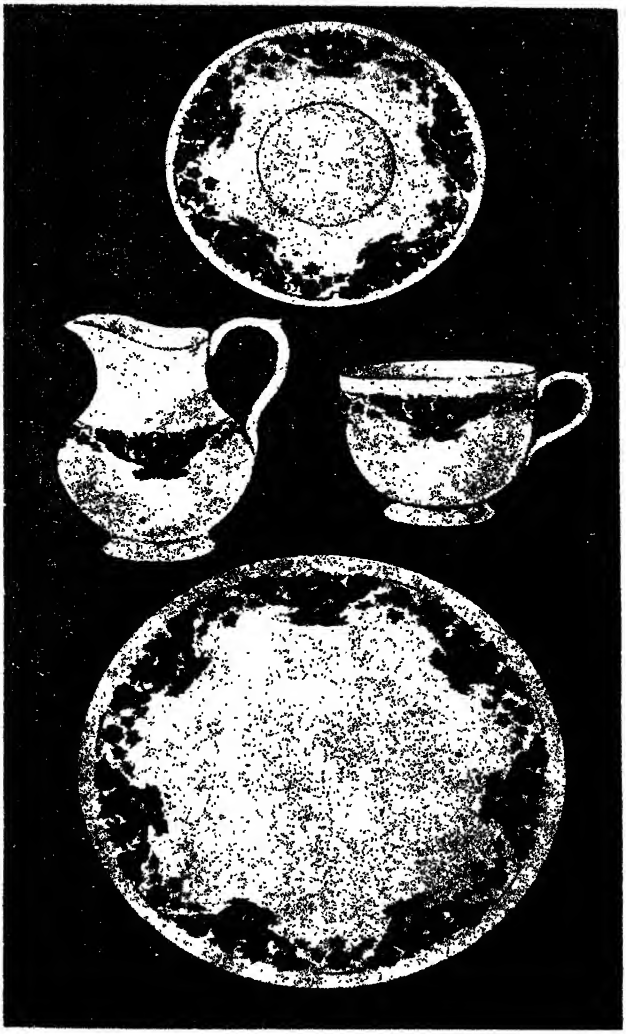
Roy S. Durber, Burslem Art School (Junior Dept.) (No. 2502.)

Fred V. Moore, Burslem School of Art. (No. 2449.)

Miss May Mountford, Hanley School of Art. (No. 2189.)

Miss Millicent J. Taplin, Hanley School of Art. (No. 2200.)

A large amount of really good work was shown in this Sub-Section, the Judges only arriving at their decisions after carefully weighing up the technical as well as the artistic points.



† Design for a Cup and Saucer, Cream Jug and Bread and Butter Plate, by Miss Catherine M. Brown.

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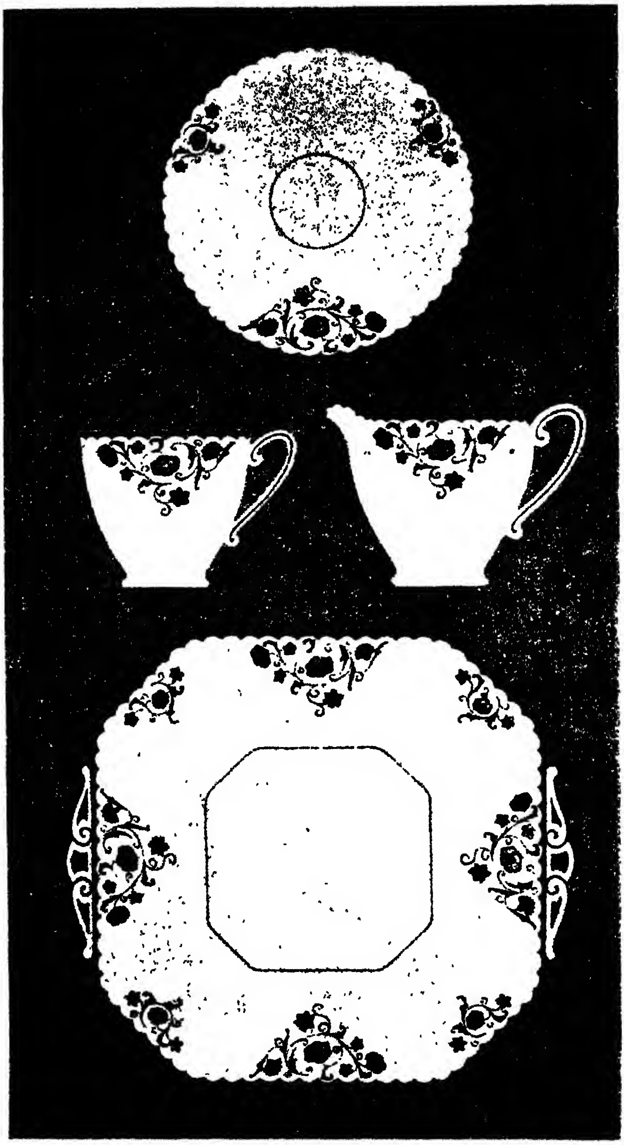

† Design for a Cup and Saucer, Cream Jug and Bread and Butter Plate by William Ruscoe.

Designs Nos. 1898 and 1372 were finally chosen as being of equal merit. No. 1372 is a technically correct design, well drawn and finished. No. 1898 has a freshness which appeals. One small point recommended to the designer is that the cream jug is a little unfinished at the top. Both look like saleable designs.

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No. 342 is a pretty design using heather as a motive, while Nos. 2502 and 2476 are both good. No. 2449 would make an attractive children's set, but is not so good for a general tea set.

Nos. 2052-7 (John Buchanan, City of Oxford School of Art), are very well drawn, but technically not sound; the narrow borders are probably too miniature and complex, whilst the heraldic lion design would be extremely difficult to apply to the tea cup or jug. We recommend this designer to try the effect of bending a piece of thin tracing paper round a shape such as the cup he shows; he would find too many creases occurring in the paper.

SUB-SECTION 2 (CHINA). *Design for a practical shaped Teapot, with suitable decoration.*

The awards are as follows:—

A Prize of £5 5s. to William Ruscoe, Stoke Art School (No. 1374.)

Commended:

Albert Capey, Burslem Art School (Junior Dept.) (No. 2491.)

William Hargreaves, Burslem Art School (Junior Dept.) (No. 2520.)

George Tams, Burslem Art School (Junior Dept.) (No. 2587.)

Some competitors placed the spout too high, which would allow the tea to pour over the top of the pot before coming out of the spout, or too low, which would not allow the pot to be filled before running out of the spout. Some made the knob on the cover so small that it would hardly serve its purpose, or would easily be knocked off.

No. 1374 was selected for an award, because it most satisfied requirements. It was well drawn, with capable handle and knob and with steady base, and would not upset easily.

Others, such as Nos. 2489-2491, would make good teapots for café or restaurant use, being strong in the handle and spout, but knobs are generally too small or weak.

SUB-SECTION 3 (EARTHENWARE). *A Dinner Plate and Vegetable Dish, of simple design, with suitable decoration.*

The awards are as follows:

Highly Commended:

Miss Doris Parton, Hanley School of Art. (No. 2191.)

Miss Millicent J. Taplin, Hanley School of Art. (No. 2201.)

Many really good designs were shown, but some were spoiled by the shape of the vegetable dish. Some competitors made it so shallow that it could be better used as a bacon dish than for vegetables. Others made the knob on the cover too thin at the contact point, or much too small for the grip.

Nos. 2191 and 2201 are both well drawn designs and are highly commended.

SUB-SECTION 4 (EARTHENWARE). *A Vase, not more than 12in. in height, with decoration suitable for either China or Earthenware.*

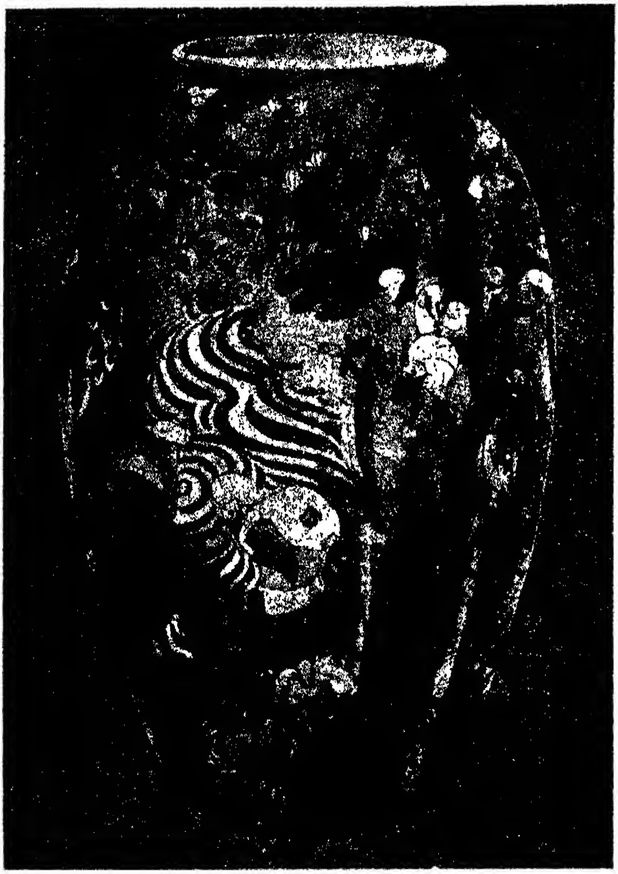
The awards are as follows:—

A Prize of £5 5s. to Miss Doris Parton, Hanley School of Art. (No. 2196.)

Commended :

Mrs. Inez Batterbury, Blackheath School of Art. (No. 345.)
Albert W. Nixon, Burslem Art School (Junior Dept.) (No. 2555.)
Victor G. Skellern, Hanley School of Art. (No. 2199.)
Miss Millicent J. Taplin, Hanley School of Art. (No. 2202.)

This Sub-Section is, perhaps, the weakest in the pottery designs, though some good designs are shown. Some competitors do not seem to realise that a vase should have



† Design for a Vase, by Miss D. Parton.

a foot wide enough to allow it to stand without being easily pushed over. Others have shown the design as if it was for a flat surface instead of a round base, lines sometimes not following the contour but coming straight down.

No. 2196 was finally chosen as showing the most originality.

To conclude: Many of the competitors show by a general similarity of design that " the factory " has had a large influence on the styles produced. To these we would recommend more study of the best pottery in Museums, to try to get more variety, by using other methods of producing artistic results, thus widening their technical knowledge and perhaps attaining newer effects than those with which they are immediately surrounded in the factory.

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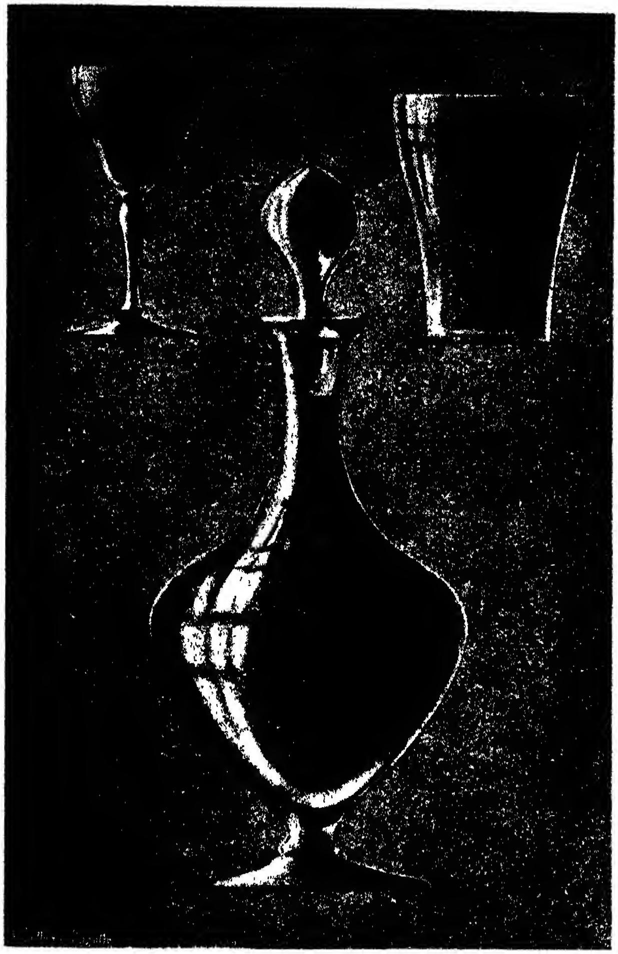

† Design for a Wine-glass, a Tumbler and a Decanter by Leonard Green.

SUB-SECTION 5. (GLASS). *A Service of Glass (i.e., a Wine Glass, a Tumbler and a Decanter) of good form, with or without decoration.*

The awards are as follows :--

A Prize of £10 10s. to Leonard Green, Wordsley School of Art and Technical Institute. (Nos. 1936 and 1938.)

SUB-SECTION 6. (GLASS). *A Centre Piece for table decoration, not exceeding 9in. in height, with decoration suitable for cutting, and Vases to match.*

The awards are as follows :—

A Prize of £10 10s. to Leonard Green, Wordsley School of Art & Technical Institute. (No. 1933.)

Highly Commended :

Leonard Green, Wordsley School of Art and Technical Institute. (Nos. 1931, 1932, 1934, and 1935.)

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The designs submitted were disappointing both in number and in originality. The Judges cannot understand why wider interest is not taken in the glass district and why students do not try to strike out more original ideas. The designs exhibited are of the type that one can see in nearly every trade catalogue. The designs sent in by Leonard Green stand out as the best in Sub-Sections 5 and 6

SECTION VI.—MISCELLANEOUS.

SUB-SECTION 1. *Prizes offered by the Empire Marketing Board for a Design for a Shop Window Bill.*

The awards are as follows :—

The First Prize of £25 and the Second Prize of £10, are divided equally between
Miss Nita Worth, Bournemouth School of Art. (No. 2124)
William Grundy, Halifax School of Art. (No. 1993.)

The Third Prize of £5 to Michael L. P. Reilly, Elmhurst, Lichfield Road, Four Oaks, near Birmingham. (No. 241.)

Commended :
Miss Astrid Barlow, Manchester Municipal School of Art. (No. 2692.)
Miss Kathleen M. Cooper, Nottingham School of Art. (No. 2936.)
Miss Phyllis Jones, Sheffield College of Arts and Crafts. (No. 2146.)
Eric Moss, Liverpool School of Art. (No. 2867.)
Raymond V. Robert, 16, Chinley Avenue, Moston, Manchester. (No. 687.)

In the opinion of the Judges, Nos. 1993 and 2124 are of equal merit, and the first and second prize are divided equally between them. The quality of the workmanship in No. 2124 is equalled by the clarity of No. 1993. The third prize of £5 is awarded to No. 241 for the originality of the design and the treatment of the pictorial portion. The lettering, both in placing and execution is not sufficiently good. No. 2936 is commended for its poster qualities, but the drawing is crude and lacking in quality. No. 2692 is commended for originality of design. The lettering, however, is poor and inconspicuous. No. 687 is commended for its lettering. No. 2867 is commended for its ingenuity, but is somewhat spoilt by its colouring. No. 2146 is disqualified for not conforming to the regulations, but is commended as having merit.

SUB-SECTION 2. *Prize offered by Messrs. Simpson and Godlee, Ltd., for design for a Poster advertising " Bevis Fabrics."*

The Prize of 50 guineas was divided and awarded as follows :
A Prize of £21 to Charles Dean, Liverpool School of Art. (No. 2833.).

A Prize of £15 15s. to each of the following :
Miss Amy Ayres, Wick Studio, Hove. (No. 1966.)
McKean E. Tatchell, 135, Upton Park Road, Forest Gate, E.7. (No. 1453.)

Highly Commended :
Miss Barbara Beaumont, Brighton Municipal School of Art. (No. 1196.)
Miss D. Bullock, King Edward VII School of Art, Newcastle-on-Tyne. (No. 7.)
Miss G. M. Dickinson, L.C.C. Hammersmith School of Arts and Crafts. (No. 2073.)
Miss Winifred Forgan, L.C.C. Central School of Arts and Crafts. (No. 849.)
Miss Marjorie Kershaw, Liverpool School of Art. (No. 2858.)
John Gordon Smith, Manchester Municipal School of Art. (No. 2778.)

Commended:

Sydney Arrobus, 50, Guilford Street, W.C.1. (No. 349.)
Francis M. Baker-Smith, Cambridge University School of Architecture. (No. 252.)
Miss Agnes Duguid, International Correspondence Schools, Kingsway, W.C.2. (No. 1251.)
Miss Anne Gilchrist, Grosvenor School of Modern Art, 33, Warwick Square, S.W. (No. 1554.)
Miss Olive F. Harris, Royal College of Art. (No. 525.)
Miss M. O. Lilley, Battersea Polytechnic School of Arts and Crafts. (No. 2275.)
Miss Barbara Stubbs, Royal College of Art. (No. 2994.)

There was a gratifying number of entries for these prizes, and the best of them reached a good standard of excellence, although there was not a great deal of originality of ideas.

The Judges felt that there was nothing of such outstanding merit as to justify the award of the fifty guineas in one prize, and they have divided the amount as shown above.

SUB-SECTION 3. *Prize offered by Messrs. C. C. Wakefield & Co., Ltd., for Poster or Showcard advertising Wakefield Castrol Motor Oils.*

The Judges were unable to recommend that the full prize of £50 should be given, but the following awards were made :—

A First Prize of £20 to Dr. John Duguid, 13, Manor Place, Cults, Aberdeen. (No. 1254.)
A Second Prize of £15 to Francis H. Bramwell, Sheffield College of Arts and Crafts. (No. 2130.)

Three equal Prizes of £5 each to
Henry W. Collins, Colchester School of Arts and Crafts. (No. 1557.)
Arthur Morrison, Liverpool School of Art. (No. 2866.)
William Southon, Manchester Municipal School of Art. (No. 2780.)

Highly Commended:
Miss May Bilbie, Nottingham School of Art. (No. 2918.)
Joseph P. McCrum, Royal College of Art. (No. 1316.)

Commended:
Robert H. Fraser, Dunedin School of Art, New Zealand. (No. 2600.)
Harry Helliwell, Halifax School of Art. (No. 2001.)
Frederick G. Osborne, Margate School of Art. (No. 1814.)

This competition brought forth very little of real originality. Many of the designs were reproductions of well-known themes, while others had only the merit of their technique.

SUB-SECTION 4. *Prize offered by Henley's Tyre & Rubber Co., Ltd., for Design for a Poster advertising the Company's Pneumatic Motor Tyres.*

The Judges recommend that the £50 Prize should be divided and three Prizes of £16 16s. each awarded to the following :—

Thomas S. Burrows, Nottingham School of Art. (No. 2922.)
Geoffrey L. Rudd, Nottingham School of Art. (No. 2957.)
Noel Syers, Goldsmiths' College School of Art (University of London). (No. 1071.)

Commended:

Cecil Cooke, Alcourt, Sandy Lane, Cheam, Surrey. (No. 22.)
Eugene Fancott, Liverpool School of Art. (No. 2840.)
Miss Doris Gully, Battersea Polytechnic School of Arts and Crafts. (No. 2273.)
John Nicolson, 16, Uffington Road, S.E.27. (No. 1343.)
Frank H. Pavely, L.C.C. Hackney Technical Institute. (No. 225.)
Roland Wigginton, 144, Hertford Road, De Beauvoir Town, N.1. (No. 419.)

It is recognised that the subject set is difficult, but the Judges found the level of originality low and the technique in a large proportion of the entries rather poor. The prize was divided because not one sketch showed sufficient originality of idea or treatment to justify the award of the full prize. The entries commended were commended for "Workmanship," rather than for originality or advertising value.

SUB-SECTION 5. *Prize offered by Messrs. W. T. Henley's Telegraph Works Co., Ltd., for a Design for a Showcard advertising the Henley Wiring System.*

The Judges were unable to recommend that the full Prize of £25 should be given, but a Prize of £10 was awarded to

Percy Bamberger, "Broadway," Chapel Lane, Frodsham, Cheshire. (No. 159.)

This competition attracted only eight entries, not one of which fulfils the requirements of the competition. None of the designs would make a showcard suitable to "*Advertise the Henley Wiring System.*" In most cases the entrants have a wrong idea of what is wanted, and have submitted designs which have no reference to the electric wiring of buildings. Telephones, Telegraph Wires and Switches have been introduced. The subject is probably a difficult one, and in a future competition the donors will give an outline of the requirements for a showcard for the subject. Mr. Bamberger's design came nearest to the object to be secured.

SUB-SECTION 6. (1) *Prizes offered by Messrs. J. S. Fry & Sons, Ltd., for a Poster advertising Fry's Breakfast Cocoa.*

The awards are as follows:—

A First Prize of £10 10s. to Frederick B. Hayes, Bath School of Art. (No. 945.)
A Second Prize of £7 7s. to Miss Edna Oakden, Manchester Municipal School of Art. (No. 2756.)
A Third Prize of £5 5s. to George F. Lunt, Liverpool School of Art. (No. 2862.)

Highly Commended:

Miss Mary Caine, Nottingham School of Art. (No. 2927.)
Frank Hilton, International Correspondence Schools, Kingsway, W.C.2. (No. 952.)
Daniel McKay, c/o Wallace, 19, Langside Road, Glasgow, S.2. (No. 1019.)

Commended:

Stanton H. Elliott, Liverpool School of Art. (No. 2837.)

The majority of competitors do not seem to have realised that the purpose of a poster is to give a message in a flash. They ought to keep in view that confusion in design and lettering destroys the value of a design as a poster. The three winning designs are thoroughly competent both in design and colour.

SUB-SECTION 6. (2) *Prizes offered by Messrs. J. S. Fry & Sons, Ltd., for a Design for a Showcard advertising Fry's Easter Eggs.*

The awards are as follows : –

A Prize of £10 10s. to Leonard Towers, Liverpool School of Art. (No. 2897.)
A Prize of £7 7s. to Miss Mary Caine, Nottingham School of Art. (No. 2929.)
A Prize of £5 5s. to Fred Clay, Bradford College of Arts and Crafts. (No. 2020.)

Highly Commended :

Harold Hemingway, Rochdale School of Art. (No. 1837.)
Miss Jennie Whitham, Leeds College of Art. (No. 1681.)

Commended :

Miss Molly Chilton-Price, Bath School of Art. (No. 637.)
Miss Gladys Rees, West Deeping, near Peterborough. (No. 207.)

This work as a whole was rather disappointing, owing to its lack of simplicity. Competitors in this Sub-Section should remember that the function of a window showcard is simply to direct attention to the goods near which it is placed amongst competing attractions.

SUB-SECTION 7. (1) *Prizes offered by Messrs. W. McKenzie & Co., Ltd., for Designs for Christmas Cards.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :–

A Prize of £10 to Henry W. Wallwork, "Netherleigh," Middlewich Road Holmes Chapel, Cheshire. (No. 1138 (b).)

A Prize of £5 for each design to the following :

Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol. (Nos. 2672 and 2673.)
Miss Marian Peck, Sheffield College of Arts and Crafts. (Nos. 2151 and 2152.)
Miss Isabel Saul, Bournemouth School of Art. (No. 2122.)

A Prize of £3 to Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol (No. 2675 (a)).

A Prize of £2 for each design to the following :

Miss Kathleen Atkins, Royal College of Art. (Nos. 1184 (d) and 1184 (f)).
Miss Berenice Butler, Popplestones, Trimley St. Mary, Ipswich, Suffolk. (Nos. 429 and 431.)
Miss Joyce Mercer, 13, Ranmoor Park Road, Sheffield. (No. 219.)
Miss Mary Mordle, Nottingham Correspondence College for Applied Designs (No. 1806 (a)).

The competition as a whole was interesting, but there were not three outstanding designs to merit award of prizes as originally offered. The prize money, therefore, was divided amongst the best as shown above.

SUB-SECTION 7. (2) *Prizes offered by Messrs. W. McKenzie & Co., Ltd., for Designs for Fancy Calendars.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £5 5s. to each of the following :

Miss Ena H. Fabian, 15, Florence Park, Redland, Bristol. (No. 2676.)
Raymond V. Robert, 16, Chinley Avenue, Moston, Manchester. (No. 689.)

A Prize of £3 3s. to each of the following:

John Buchanan, Oxford School of Art. (No. 2059.)
Miss Marjorie Carter, Leeds College of Art. (No. 1066.)
Miss Marianne Edwards, 78, Onslow Gardens, Muswell Hill, N.10. (No. 38.)

The competition fell entirely short of its aim, and it was impossible to award the maximum prizes. The above designs, however, have some merit.

SUB-SECTION 8. *Prizes offered by Messrs. Hodder & Stoughton, Ltd., for three Hodder & Stoughton Designs for advertisements in the Press.*

(1) *Design for Novels* (2) *Design for General Books.* (3) *Design for Religious Books.*

The Judges were unable to recommend that the three full Prizes of £5 5s. should be given, but the following awards were made:—

A Prize of £3 3s. to Thomas H. Jenkin, A.R.C.A., 3, Stafford Street, Dunedin, New Zealand. (No. 212.)

A Prize of £2 2s. to each of the following:

James L. Carstairs, 15d, Avonmore Road, W.14. (Nos. 61 to 63.)
Brian M. Gilks, International Correspondence Schools, Kingsway, W.C. (No. 93.)

Highly Commended

Miss Mary Caine, Nottingham School of Art. (No. 2931.)
Richard Mallett, Lowestoft School of Art. (No. 1789.)

Commended:

Bernard Griffin, 40, Roland Road, Handsworth, Birmingham. (Nos. 513 to 516.)

The competitors have not grasped the purpose of this competition. Most of the designs incorporate hackneyed symbols, and, with few exceptions, shew no original conceptions, and have not grasped the initial commercial requirements. In the religious designs competitors have failed to appreciate the need for catholicity of expression.

SUB-SECTION 9. *Prize offered by Messrs. Catesbys, Ltd., for a Design for a Booklet Cover of Catesbys' Cork Lino.*

The awards are as follows:—

A Prize of £7 7s. to George F. Yarnell, 450, Upper Richmond Road, Richmond, Surrey. (No. 1171.)

A Prize of £3 3s. to Miss Violet Stacey, Letchworth C.C. Elementary School. (No. 705.)

Commended:

Arthur J. Cooper, 64, Grove Avenue, Twickenham, Middlesex. (No. 789), for novelty of idea in the method of display.
Miss Honor Howard-Mercer, Guildford School of Art. (No. 979.)

All the designs submitted were creditable, and the candidates appear to have grasped the main ideas of the competition.

SUB-SECTION 10. (1) *Prizes offered by Messrs. Joseph Nathan & Co., Ltd., for a Design advertising Glaxo or Glax-ovo.*

The awards are as follows :—

A First Prize of £25 to George H. Tomlinson, Manchester Municipal School of Art. (No. 2787.)

A Second Prize of £5 5s. to Miss Barbara Shipley, Nottingham School of Art. (No. 2962.)

Highly Commended :

Miss Eleanor M. East, Brighton Municipal School of Art. (No. 47.)
Miss Barbara Shipley, Nottingham School of Art. (No. 2960.)

Commended :

George H. Tomlinson, Manchester Municipal School of Art. (Nos. 2785, 2786, and 2788.)

George H. Tomlinson's design (No. 2787) was selected for first prize because it shews what the food does or the result from taking it. In contrast, No. 47 shows what the food is composed of. The bulk of people are influenced to purchase a food by results; if, however, they were purchasing a motor car or an incubator, mechanical details of construction would be important. For instance, with a baby food, most mothers have not the knowledge of what a baby food should be, nor have they much knowledge of what a baby should have; this is also true of adults. That Glaxovo is composed of highly nutritive constituents, easily digested, quickly prepared, is not as strong a selling point as that it will provide sleep for the sleepless, feed jangled and starved nerves, or provide a quickly prepared supper dish. In effect, what the food does is the primary sales point ; what it is composed of the secondary one, and this has been the fundamental basis on which the Judges have made their selection.

SUB-SECTION 11. *Prizes offered by Messrs. Rowntree & Co., Ltd., for a Window Display Piece.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £10 to Harold Kenneth White, Blackheath School of Art and Crafts. (No. 1465.)

A Prize of £5 to Miss Daphne Barry, Battersea Polytechnic School of Arts and Crafts. (No. 2256.)

Commended :

Miss Grace M. Hawkins, " Ravenhurst," Westgate-on-Sea, Kent. (No. 920.)

In connection with the design for a Window Display Piece, the two previous Competitions proved to be more or less in the nature of an educational period in so far as this section of art work was new to most students. This year a large number of applications was received for references and photographs, and it was anticipated that an increased number of designs would be submitted, but this was not the case, and 20 only were received. The designs this year were a little better than in previous years, but no entry merited first prize. The Judges, however, awarded consolation prizes as shown above.

GENERAL NOTE.

Department of Scientific and Industrial Research—Building Research—Bulletin No. 5—The Properties of Breeze and Clinker Aggregates and Methods of Testing their Soundness.—Since the publication more than a year ago, of a report upon the general properties of breeze and clinker and their use as concrete aggregates, work has been in progress at the Building Research Station on the causes of failure experienced with concrete made with these materials. In this Bulletin a survey of these causes is presented in non-technical language, and two simple methods of testing the soundness of breeze and clinker aggregates are given. These tests have been designed for use on the job, without the aid of laboratory apparatus. It is hoped that these tests may help to minimise failure and to assist the builder to select and use with confidence a cheap material, which, if free from harmful constituents, possesses properties which make it suitable for a number of purposes. A complete account of the investigations upon which this Bulletin is based will be published as a separate technical paper. The Bulletin may be obtained, price 6d. (postage extra), from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2, or through any bookseller.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, December 17..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Mr. Basil Ionides, "Modern Glass."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Papers to mark the Bicentenary of Captain Cook, including an appreciation of his life written by Sir Henry Newbolt.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. J. R. Duggan, "Suction Gas as an Automobile Engine Fuel."

North-East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne. 7.15 p.m. Mr. John Neill, "Could the Method of Conducting Measured Mile Trials be Improved?"

University of London, at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen. Sir Frederick Maurice, "Allenby's Campaigns in Palestine." (Lecture II).

Tuesday, December 18..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Miss R. M. Fleming, "A Study of Growth in Children: its Ethnological and Educational Significance. An Analysis of Six Years' Consecutive Measurement."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. J. H. Nicholson, "The Reconstruction of the New Holland Pier."

Heating and Ventilating Engineers, Institution of, at Milton Hall, Deansgate, Manchester. 7 p.m. Mr. A. B. Crompton, "Drying in Laundries."

Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. 6 p.m. Mr. Charles Eastwood, "Corsica. Napoleon's Beautiful Island Home."

Mechanical Engineers, Institution of, at the Queen's Hotel, Birmingham. 6.30 p.m. Dr. H. W. Swift, "Power Transmission by Belts: An Investigation of Fundamentals."

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Mr. H. E. Soper, "The Interpretation of Periodicity in Disease Prevalence."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. H. J. Butler, "Commercial Motor Vehicles, their Varieties and Uses."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. A. Drysdale Wilson, "The Elimination of Street Accidents."

Wednesday, December 19..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. I. W. G. Freeman, "The Harbour Improvement Scheme at St. Peter Port, Guernsey."

Electrical Engineers, Institution of, at the Cleveland Technical Institute, Middlesbrough. 7 p.m.

Geological Society, Burlington House, W. 5.30 p.m. Prof. W. J. Pugh, "The Geology of the District between Llan-y-Mawddwy and Llanuwchllyn."

Mechanical Engineers, Institution of, at the Technical School, Lincoln. 6.30 p.m. Mr. H. R. Ricardo, "Internal-Combustion Engines."

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. (1) Mr. L. H. G. Dines, "The Dines Float Barograph"; (2) Dr. J. Glasspoole, "The Distribution of the Average Seasonal Rainfall over Europe."

Microscopical Society, 20, Hanover Square. 7.30 p.m. (1) Messrs. E. Heron-Allen and A. Earland, "Some Further Notes on the Pegididæ"; (2) Prof. E. Ghosh, "A New Parasitic Ciliate from the Intestine of the Bengal Monkey (*Macacus rhesus*)."

Thursday, December 20..Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. C. K. Ingold and C. C. N. Vass, "Influence of Poles and Polar Linkings on the Course Pursued by Elimination Reactions. Part II. Mechanism of Exhaustive Methylation." (continued). (2) Messrs. G. W. Fenton and C. K. Ingold, "Influence of Poles and Polar Linkings on the Course pursued by Elimination Reactions. Part III. A Decomposition of Dialkylsulphones." (3) Messrs. G. T. Morgan and R. A. S. Castell, "Researches on Residual Affinity and Co-ordination. Part XXXI. Molybdyl bis-β-diketones." (4) Messrs. G. T. Morgan and F. H. Burstall, "Interactions of Selenium Oxychloride and Phenols." (5) Messrs. C. K. Ingold and E. Rothstein, "Influence of Poles and Polar Linkings on Tautomerism in the Simple Three-Carbon System. Part I. Experiments illustrating Prototropy and Anionotropy in Trialkyl propenylammonium Derivatives." (6) Mr. S. Sugden, "The Parachor and Chemical Constitution. Part X. Singlet Linkages in Chelated Coordination Compounds."

Electrical Engineers, Institution of, Savoy Place, W.C. 5.30 p.m. Commemoration of the Jubilee of the Incandescent Electric Lamp. Lecture by Mr. James Swinburne, F.R.S., on Sir Joseph Swan's work.

6 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

Mechanical Engineers, Institution of, at the Queen's Hotel, Birmingham. 6.30 p.m.

At the Engineers' Club, Manchester. 7.15 p.m. Mr. E. G. Herbert, "Machinability."

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

At the Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Eric Maclagan, "Bernini and the XVIIth Century."

Friday, December 21..British Electrical Development Association, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Mr. J. E. Tapper, "Hire and Hire Purchase in Electrical Development Schemes."

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Mr. Paul Edmonds, "Burma and the Burmese."

University of London, at the University Union Society Rooms, Malet Street, W.C. 5.30 p.m. Dr. Otakar Odložilík, "England and Bohemia." (Lecture III).

JOURNAL OF THE ROYAL SOCIETY OF ARTS.

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FRIDAY, DECEMBER 21st, 1928.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on "Ships and Lighthouses" at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides. The syllabus of the lectures is as follows:—

LECTURE I—THE STORY OF THE SHIP.—This will tell the story of the ship, from the far off times of the British coracle down to the present day. The slides will show the development of the merchant ship and the battleship, including at the close the great Atlantic liner and the super Dreadnought. The story will tell how our life in these islands "rose not, grows not, comes not save by the sea."

LECTURE II.—LIGHTHOUSES.—This will tell how the lighting of our coasts began, how it has grown, and who directs it. It will describe the tower, the illuminant, the changes from coal and wood in an open brazier to oil and electricity, and the coming of directional wireless. It will deal with the lives of the watchers in the lonely rock lights, and show the service that the lighthouse keeper and lightshipman render to the sailor.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

COUNCIL.

A meeting of the Council was held on Monday, December 10th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Sir Atul C. Chatterjee, C.I.E.; Sir Alexander Gibb, G.B.E., C.B.; Mr. John S. Highfield,

M.Inst.C.E., M.I.E.E.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Francis G. Ogilvie, C.B., LL.D.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society :—

Bradby, Anthony Strudwicke, London.
Brice, Edward Kington, Ashton-under-Hill, Nr. Evesham.
Brown, Henry J., London.
Burgess, Edward Elman, Leeds.
Clift, Sidney, Bloxwich, Staffs.
Fisher, Ernest Arthur, M.A., D.Sc., St. Albans.
Ganguli, S., Baroda, India.
Hilditch, John, Manchester.
Hipwell, Miss Hermine Hallam, London.
Holmes, Kenneth, London.
Hopley, John Woodrow, London.
Law, A. Francis, M.B., B.Sc., Kuching, Sarawak.
Logsdail, William, Noke, Nr. Islip, Oxford.
Marjoribanks, Sir George John, K.C.V.O., London.
Morley, Cyril, Bakewell, Derbyshire.
Pledger, Robert Howland, B.Sc., Ewell, Surrey.
Poland, Eustace Bernard, Worthing.
Rhys-Jenkins, Lieut.-Colonel Griffis W., London.
Rosenblatt, Maurice C., Philadelphia, Pa., U.S.A.
Ross, Victor, Toronto, Canada.
Rundell, John William, Rochester, Kent.
Ryland, Alfred Samuel, A.R.C.A., Loose, Nr. Maidstone.
Sellers, Horace Wells, B.Sc., Philadelphia, Pa., U.S.A.
Slipper, Harold Frederick, Harston, Cambs.
Smart, Borlase, R.O.I., R.W.A., Salcombe, Devon.
Smith, Hely A. M., R.B.A., London.
Tilling, E. W., Bromley, Kent.
Tomlins, William Edward, Tutye, Victoria, Australia.
Wren, Henry, Oxshott, Surrey.

The Report of the Departmental Committee on Examinations for Part-Time Students was further considered.

A letter from the Gloucestershire Rural Preservation Committee was read congratulating the Society on their action in purchasing for permanent preservation the group of cottages known as Arlington Row, Bibury.

Dr. P. M. Evans, LL.D., was appointed to represent the Council on the Chadwick Trust, in place of Sir Frank Baines, K.C.V.O., C.B.E., resigned.

The Chairman of the Council, Sir William Davison, K.B.E., D.L., M.P., Sir Philip Magnus, Bt., and Mr. A. A. Campbell Swinton, F.R.S., were appointed to represent the Council on the Joint Committee of the Royal Society of

Arts and the Royal College of Physicians to consider the award of the Swiney Prize for the best published work on Medical Jurisprudence.

The Chairman of the Council, Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., Mr. J. S. Highfield, M.Inst.C.E., M.I.E.E., the Hon. Sir Charles Parsons, O.M., K.C.B., D.Sc., F.R.S., Mr. James Swinburne, F.R.S., and Mr. A. A. Campbell Swinton, F.R.S., were appointed as a committee to examine the Report on the British Patent System, prepared under the auspices of the British Science Guild.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

SIXTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 12TH, 1928. SIR OLIVER J. LODGE, M.A., LL.D., D.Sc., F.R.S., in the Chair.

A paper on "Applications of Electricity to Medical Practice," was read by Mr. G. G. Blake, M.I.E.E., F.Inst.P. The paper and discussion will be published in the *Journal* on January 18th.

DOMINIONS AND COLONIES SECTION.

FRIDAY, DECEMBER 14TH, 1928. DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.R.S., F.L.S., in the Chair.

A paper on "The Improvement of Negro Agriculture," was read by the RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D. The paper and discussion will be published in the *Journal* on January 25th.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

MONDAY, DECEMBER 3RD, 1928.

SIR REGINALD A. MANT, K.C.I.E., C.S.I. (Member of the India Council), in the Chair.

THE CHAIRMAN said that Sir James MacKenna possessed special qualifications to deal with the subject of his lecture. Sir James had been for many years Agricultural Adviser to the Government of India, and President of the Agricultural Research Institute at Pusa—an Institute which had done such wonderful work for Indian agriculture. Recently he had been a member of the Royal Commission on Agriculture in India. In addition to his general knowledge of agricultural conditions in India, Sir James had taken a special interest in the question of sugar

production, and it had been largely at his instance that a Committee had been appointed by the Government of India in 1918 to go into this question. Sir James had been appointed Chairman of that Committee. Unfortunately, other duties had called him away before the Committee's labours were finished, but the audience that evening would find that he had continued to take an interest in the subject.

The following paper was then read:—

THE INDIAN SUGAR INDUSTRY.

By Sir James MacKenna, C.I.E.

I think I may modestly claim that the last word on Indian sugar was said in the report of the Indian Sugar Committee, of which I was the original President. What, therefore, I say to you this afternoon may have a very strong resemblance to the report of that Committee. And, after its exhaustive examination of the subject in all its aspects, there is little new to add. But a general survey of the position in a somewhat shorter compass than that of the report may, I hope, serve to give an impression of the sugar industry of India which may be of interest.

The Origin of Sugar Cane.

Prinsen Geerligs, whose book, "The World's Cane Sugar Industry, Past and Present," is probably the most authoritative work on the subject, gives it as his opinion that in all probability the sugar cane originally came from India, more especially from the banks of the Ganges. He adds, however :—

> "We cannot be absolutely certain of this, as at the present day tropical sugar cane in its wild state is not found anywhere.
>
> "The probability, however, of its originating from India is very strong, as only the ancient literature of that country mentions sugar cane, while we know for certain that it was conveyed to other countries by travellers and sailors.
>
> "According to Hindu mythology, sugar cane was created by the famous hermit Vishva Mitra to serve as heavenly food in the temporary paradise which was organised by him for the sake of Raja Trishanku. This prince had expressed his wish to be translated to heaven during his lifetime, but Indra, the monarch of the celestial regions, had refused to admit him. In order to meet his wish, Vishva Mitra prepared a temporary paradise for him, but when a reconciliation between the two rajas was brought about, the paradise was demolished and all its luxuries destroyed except a few, including sugar cane, which was spread all over the land of mortals as a permanent memorial of Vishva Mitra's miraculous deeds.
>
> "The fellow-travellers of Alexander the Great, and afterwards writers who made use of their notes, tell us of a reed growing in India which produced honey without the aid of bees. We also find sugar cane repeatedly mentioned as a tribute to the Emperor of China from the Indian border provinces, which also accounts for sugar cane having spread as far as the East."

BOTANICAL.

It seems hardly necessary in a paper of this kind to go deeply into the botany of sugar cane, a subject which has been very thoroughly investigated by many workers. Suffice it to say that the true sugar cane all belongs to the genus *Saccharum*, and of the numerous sub-genera only *S. Officinarum* and *S. Spontaneum* are true sugar canes. Of these, *S. Spontaneum* occurs abundantly in the wild state in India and other parts of Southern Asia and in many of the Pacific Islands. According to Barber, who has studied the wild forms carefully and used them for crossing on cultivated kinds, this is an exceedingly variable species. The evidence is conclusive that the slender cultivated kinds of Northern India (including *Uba*, which attracted so much attention in Porto Rico because of its immunity to mosaic diseases) are nothing more than selected forms of this wild species.

S. Officinarum was founded by Linnaeus on the cultivated thick-stemmed tropical sugar canes. It has always been held that this constituted a distinct species, but no wild representative of it has ever been found. It seems not improbable that all cultivated sugar canes, both thick and thin stalked varieties, may, in fact, be descendants of the wild *S. Spontaneum*.

ACREAGE UNDER CANE.

The five-yearly average of acreage under cane for the periods 1890-01 to 1924-25 and the annual average of the last three years in India are as follows :—

1890–91 to 1894–95 ...	 2,863,400	acres
1895–96 ,, 1899-1900	 2,735,400	,,
1900–01 ,, 1904–05 ...	 2,375,600	,,
1905–06 ,, 1909–10 ...	 2,385,000	,,
1910–11 ,, 1914–15 ...	 2,511,000	,,
1915–16 ,, 1919–20 ...	 2,794,800	,,
1920–21 ,, 1924–25 ...	 2,794,800	,,
1925–26 ,, 1927–28 ...	 2,950,000	,,

A study of these figures shows that from 1900 to 1914, when cheap imports of foreign sugar were pouring into India, the area under sugar cane showed contraction, while from 1914 onwards, as a result of the War and its after-effects, imports became more difficult, sugar rose in value, and the area under cane in India increased.

Another point that emerges from these average figures is that, although the population in India has increased enormously during the last three decades, the area under sugar cane, from which the requirements of the country in the matter of *gur* or *jaggery* can be met, has only recently overtaken the acreage in the nineties. Meanwhile, the imports of foreign sugar have more than quadrupled. We have no reason to believe that there has been any appreciable increase in the amount of *gur* obtained from this acreage, and the inference would seem to be either that the consumption of *gur* per head of the population

is falling off or else that a large number of people do not consume *gur*, but use imported refined sugar. But even if this assumption is correct the annual consumption of *gur* is enormous. In his presidential address in the section of agriculture at the Indian Science Congress this year Rao Bahadur Venkataraman, the present sugar cane expert, analysed the Indian consumption of sugar and its products as follows:—

> "The annual consumption of *gur* and sugar combined is roughly a little over three and a quarter million tons, of which about 75% consists of *gur* and country sugar. Of the remaining 25% about 3-4% is crystal sugar, home-made in more or less modern factories and refineries working in this country. The remainder, that is, between 21-22%, has to be imported each year from outside, chiefly from Java, at a total cost of about fifteen crores of rupees."

In view of this position it is clear that the claims of improved *gur* manufacture must figure prominently in any scheme for the betterment of the Indian sugar industry. Research work is necessary to place this cottage industry on a proper and less wasteful basis, for it is improbable that it will ever entirely disappear from India. The subject has received some attention. The introduction of improved furnaces like the Sindewahi, the substitution of three-roller iron mills for the old stone and wooden mills, and the use of better boiling pans, have undoubtedly effected a certain amount of good, but there is much room for further investigation both into the process of manufacture and, in particular, into the question of fuel. A very important side of the activities of any agency set up for the improvement of the Indian sugar cane industry will be connected with the problems of *gur* manufacture.

India as an Exporter of Sugar.

In all discussions on the Indian sugar position it is a common-place to emphasise that at one stage India was a considerable exporter of sugar, whereas latterly, and for a very large number of years, she has been an importer. The early records of the East India Company from 1609 onwards indicate an European enquiry for Indian sugar and various trial consignments are referred to.

When we come to more recent years the following figures of Indian exports of sugar to Great Britain may be of interest:—

In 1800 the British imports from India, expressed as raw sugar, came to 6,023 tons; in 1821, to 13,861 tons. Some twenty years later Indian exports to Great Britain amounted to 96,875 tons; in 1851, to 75,307 tons. The next decade marked great shrinkage, as the exports to Great Britain fell to 34,800 tons only. Expansion of the industry in British Colonies under European management and control proved a serious competitor and, in fact, ultimately killed the Indian trade.

It seems unnecessary to give the variations in export of sugar, raw or refined, for any long period of years; the present position is summarised in the figures for 1924–25, 1925–26, 1926–27.

EXPORTS TO ALL DESTINATIONS.

	1924–25 Tons.	1925–26 Tons.	1926–27 Tons.
Sugar, both raw and refined	1,058	600	627
Jaggery	20,002	1,924	1,487

It will thus be seen that the export trade in sugar has practically vanished. One may, perhaps, be permitted to question the economic soundness of the position when India was an exporting country, for there are indications that even then India, instead of turning its attention to the manufacture of superior qualities of sugar within its own borders, was a considerable importer of the refined article from China and Egypt. The position would appear to have been that the art of refining sugar was not generally known to the people of India. A couple of centuries ago, therefore, India consumed a far larger proportion relatively of crude sugar (*gur*) than it does to-day. The East Indian Company made strenuous efforts to develope internal trade and stop imports in these early days by meeting the demands of Bombay from the surplus stock of Bengal, and, to facilitate this, transit dues on sugar were removed and an import duty placed on foreign supplies. Even with this protection Indian sugar did not assume control of its own markets. Large supplies continued to pour in from Egypt and China. In later years Batavia and the Straits, Mauritius and the West Indies, became formidable producing centres and exporters to India, while another disturbing factor was introduced—the large supplies of cheap beet sugar which appeared in India from Europe. The inevitable result of all this outside competition has been a slow awakening to the fact that India must turn her attention to the improvement of her own refined sugar if she is to compete in this market at all.

INDIA AS AN IMPORTER OF SUGAR.

The figures for export fade into utter insignificance when compared with those of import. These show a progressive increase annually as a decennial review will indicate. In 1871–72 India imported about 28,000 tons of crystallised sugar; ten years later the figure was about 49,000 tons and in 1891–92 over 125,000 tons. At the beginning of this century imports were over 275,000 tons, consisting of equal proportions of beet and cane sugar. In 1926–27 the total imports amounted to no less than 826,900 tons, of which Java contributed 611,700 tons. I understand that the figures are now even higher. The foreign imports of sugar have so firmly established themselves that it seems likely that they will be a permanent feature of the situation. This foreign competition has always caused a certain amount of anxiety in India and the method of combating it has generally been by means of Tariffs.

TARIFFS.

Until the Mutiny the general rate of import duty levied in India was 5%, but owing to the financial stringency consequent upon the Mutiny it was necessary

to increase it to 10%. In 1864 the rate was 7½%, reduced in 1875 to 5% again. In March, 1899, under the Indian Tariff Amendment Act, duty was imposed on bounty-fed sugar from foreign countries. This Act was framed with the intention exclusively of counter-vailing bounties paid directly or indirectly by foreign governments, and gave the Government of India power to impose additional duty on sugar imported into India equal to the net amount of bounty or grant paid or bestowed directly or indirectly by the country, dependency or colony exporting such sugar, however that bounty might be paid or bestowed. But this did not stop the influx of cheap European sugar. The closing of the American markets as a result of the Act of 1897, which imposed counter-vailing duties on bounty-fed sugar, resulted in the diversion of still larger supplies of European sugar to the Indian market. To counter-vail this artificial surplus the Tariff Amendment Act No. VIII of 1902 was passed, the relevant clause of which is :--

> "Where the rate of duty or other taxation imposed in any country, dependency, or colony upon sugar not produced therein exceeds the rate of duty or other taxation imposed on sugar produced therein by more than the equivalent of six francs per one hundred kilogrammes in the case of refined sugar or five francs and fifty centimes per one hundred kilogrammes in the case of other sugar, then the Governor-General in Council may impose, in addition to any other duty or taxation imposed by this Act or by any other Act for the time being in force, a special duty not exceeding one moiety of such excess."

The immediate effect of this legislation was to diminish imports of sugar from Europe and to divert trade principally carried on with India by Germany and Austria, to countries which did not come within the scope of the new legislation. Fresh supplies of cane sugar were thus liberated, which poured into India. Imports of beet sugar in 1902–03 were only about half those of 1901–02, while imports of cane sugar from Mauritius, Java, and China, increased by more than 40%. Eventually, in December, 1903, orders were issued remitting the counter-vailing duties chargeable on sugar produced, after August of that year, in countries which have limited their direct or indirect bounties on sugar and their protective duties, to the minimum permitted by the Brussels Convention of 1902.

Before the outbreak of the Great War sugar was admitted into India free of all legislative restrictions except the ordinary import duty of 5% on all foreign goods, and the counter-vailing duties against sugar produced in or exported from certain countries (Denmark, Chili, Argentine Republic, Russia, etc.), which had not adhered to the Brussels Convention. The import duty was raised to 10% *ad valorem* in 1916, 15% *ad valorem* in 1921 and 25% *ad valorem* in 1922. It was converted into the present specific duty from 1st June, 1925, and amounts to Rs. 4–8–0 per cwt. of sugar 23 D.S. and above, and of Rs. 4–0–0 on sugar from 8 D.S. to 22 D.S. Sugar below 8 D.S. is subject to an *ad valorem* duty of 25%.

In spite of the very substantial amount of protection which these import duties afford there is a tendency in certain quarters to demand still higher protective duties. Personally, I am of opinion that the limit of protection by tariffs has been reached and I do not consider that any further assistance on the lines of a protective tariff would be justifiable. In connection with these import duties it is pertinent, however, to remark that they are avowedly intended for revenue purposes, and they have admirably fulfilled this intention, as they now bring over six crores of rupees annually to the Government of India. I think it may also be admitted that they have afforded a certain measure of protection to the local sugar industry and, had it not been for this duty, Java, which with its highly-organised industry can manufacture sugar at Rs. 5 per maund, would have been able to dominate completely the Indian sugar trade. On the other hand, the Indian import duty has not checked imports to any appreciable extent, and as the price of sugar has come down from over Rs. 30 per maund in 1920 to Rs. 10 per maund now, the protective duty does not much affect the consumer. The protective policy has also, I think, acted to an extent as an encouragement to Indian sugar manufacture and has probably saved the industry from complete extinction. As I have said, however, tariffs have reached their limits, and it is in other directions we must look for any permanent improvement of the position. Let us now consider what has been, and is being, done to improve Indian sugar cane.

WORK BY THE AGRICULTURAL DEPARTMENTS.

Since the Departments of Agriculture were re-organised in 1905, the question of improvement of the Indian sugar industry has received considerable attention. At the meeting of the Board of Agriculture at Cawnpore in February, 1907, exhaustive material was prepared on the lines of a scheme suggested by Dr. Barber, then Government botanist of Madras, for an official enquiry into the Indian sugar cane industry. A report on the position in each province was submitted and examined, and as a result the Board of Agriculture urged local governments to consider the advisability of granting concessions to central factories when suitable tracts for the establishment of such factories could be found, and indicated the lines on which sugar cane experiment stations should be established and conducted. The Government of India left it to local governments to deal with these recommendations, but it is to be feared that very little action was taken on them.

The matter again came before the Board of Agriculture at their meeting in 1911, and a series of resolutions were passed, of which the most important were:—(1) that the sugar cane industry deserved the assistance of the Government; (2) that the Board accepted the recommendation of the Committee regarding the employment of a sugar engineer; (3) that the establishment of a sugar station on the north of the Ganges was most desirable in the interests of the industry; (4) that the Board accepted the recommenda-

tion of the Committee regarding the establishment of an acclimatization and cane-breeding station in Madras. These recommendations were fortified by a resolution of the Imperial Legislative Council on the 9th March, 1911, which advocated a special enquiry with a view to preventing contraction of Indian sugar cultivation owing to the import of foreign sugar. As a result the Government of India took action. A sugar engineer was appointed by them to work under the Government of the United Provinces. A small government factory was erected at Nawabganj, designed to turn out one and a half tons of sugar per day of 24 hours. It was a five roller mill and the equipment differed little from that of the modern factory except for the omission of an intermediate vacuum evaporator. The factory, as far as efficiency of the mill was concerned, was a success, but the experiment failed because the evaporating capacity was not equal to the crushing power, while great difficulty was experienced in securing adequate supplies of cane. The experiment demonstrated that the direct manufacture of white sugar in small factories with open pan boiling is unlikely to succeed on account of the high cost of production, heavy loss of crystalline sugar, and unduly high proportion of molasses.

It was the fourth resolution of the Board of Agriculture in 1911 that was destined to bear greatest fruit. The Government of India accepted the Board's recommendation and in 1912 submitted a proposal to the Secretary of State that an acclimatization and cane-breeding station should be established at Coimbatore in the Madras Presidency, and that Dr. Barber should be placed in charge of it for a period of five years. At first, control of the appointment was left to the Provincial Government on the understanding that the officer appointed would be expected to tour throughout India and use his appointment for the benefit of all Provinces alike, the expenditure being met by the Government of India. Dr. Barber entered on his duties on the 1st October, 1912, and retired in 1919. It is impossible to over-estimate the value of the work which he did for the sugar cane industry of India during his appointment, and it is safe to say that if the work is continued along the lines laid down by him and under competent supervision the thin cane problem of India will be solved. The work has now been made permanent, and been taken over by the Government of India. A second officer is being recruited to do breeding work on thick canes. The Coimbatore station has already more than justified its existence by the evolution of new cross bred canes, some of which, notably Coimbatore 205/210, 213/214, are now grown in extensive areas of the Punjab, United Provinces, Bihar, and Bengal. In the western circle of the United Provinces the area under Coimbatore canes is some 40,000 acres, while in Northern Bihar it is over 12,000 acres. Not only do these canes give a higher yield, but they have the further advantage that they do not demand a standard of cultivation and manuring which it is beyond the power of the cultivators in these parts to give them. The introduction of these Coimbatore seedlings in the sugar tracts of Northern India has completely revolutionised the position so far as the white

sugar industry is concerned, and upon their further spread depends largely the extension of sugar refineries in Northern India.

As regards the thick canes, much valuable work has been done by Mr. George Clarke at Shajahanpur, by successfully introducing exotic varieties and by careful attention to all agricultural processes involved in their cultivation. Very large tracts in the United Provinces are now under these improved selected canes.

It is, however, important to realise that even with reference to the *gur* industry, the value of the improved canes which are being introduced will be very largely diminished if improved methods of crushing and boiling do not go hand in hand with the increased yield. At present Coimbatore canes are being distributed fairly rapidly and widely, but a really efficient mill to deal with them has not yet been discovered. Until the manufacturing side of the country sugar industry is made efficient, the increased cane yields will merely increase the waste and the benefit to the cane grower will be largely lost.

The improvement of the faulty methods of dealing with the cane will first be reflected in the improvement of the *gur* and *rab* industry. But to check import of foreign sugar, the establishment of modern efficient factories is the only solution. India at present is not making the fullest use of her raw material; the waste that is going on is simply colossal. The acreage under cane last year was 3,071,000 acres and if we deduct 16 p.c. as providing cane for chewing, setts for planting, and for cattle fodder, we are left with 2,580,000 acres. Out of this, roughly, only 80,000 acres provide cane for the manufacture of sugar in modern factories. The produce of the remaining area is converted into *gur* or raw sugar.

As Mr. Noel Deerr has pointed out, by following the present cane crushing and *gur* boiling processes, India makes 2,500,000 tons *gur* (10 tons cane per acre as average yield and 10 maunds of *gur* as the average outturn from 100 maunds cane). This *gur* at the average value of Rs. 5/per maund, or Rs. 140 per ton, fetches Rs. 35,00,00,000. If the produce of these 2½ million acres is converted into sugar in an efficient modern factory (recovery 9 p.c. on the weight of cane), 2,250,000 tons sugar and 820,000 tons molasses will be turned out. Taking the selling price of sugar at Rs. 300 per ton, we get a value of Rs. 67,50,00,000 and molasses at Rs. 1/per maund or Rs. 28 per ton, will be worth Rs. 2,20,60,000=Rs. 69,79,60,000, or Rs. 34.8 crores more than can be realised from *gur*. No other country in the world could stand such colossal waste of available material. The responsibility which rests on all concerned for putting an end to this state of things is great. There are at present only 40 sugar factories and refineries and their combined output is hardly 100,000 tons per annum, while India imports over 800,000 tons a year. It will thus be clear that there is ample scope for many more factories and they will not have to look for outside markets, as the demand for the sugar turned out in Indian factories is at their very doors.

The late War is responsible for an awakening interest in the development of the sugar industry. Sir Claude Hill, in his opening speech at the tenth meeting of the Board of Agriculture, which was held at Poona in December, 1917, stated that the War had brought to a head the desirability of dealing with the sugar cane question in India on a more thorough and scientific footing and that it had also served to show the opportunity afforded in the matter of sugar of bringing about a situation in which India may become not only self-contained in the matter of its production but may even become an exporting country. It was felt that as a preliminary it would be desirable to bring together and co-ordinate the scattered work on the subject that had been, or was being, done in the different Provinces and that this could best be effected by a Bureau of Information, where all work done could be reviewed and the masses of information already available in the country sifted and collated. Accordingly, proposals for the formation of a Bureau were submitted by me in July, 1918. The full scheme provided for a factory expert, an engineer, a chemist, an agriculturist and botanist, with an officer as Secretary of the Bureau. I suggested, however, that it would be sufficient to develop the scheme in two stages, the first stage involving only the appointment of a Secretary to the Bureau and a sugar Technologist. This stage of the proposals was accepted by the Government of India, who sanctioned the formation of a Bureau with Mr. Wynne Sayer as Secretary, but the question of the appointment of a Technologist was held over for further consideration. Unfortunately, elaboration of the scheme has gone no further than this and the only appointment that has been made is that of Secretary to the Sugar Bureau. The Bureau has been in existence for the last nine years, and I give the following appreciation of it by Dr. Barber as recorded in his evidence before the Royal Commission on Indian Agriculture :—

"I have followed the reports of the Secretary on the Sugar Bureau year by year, with great interest, and I would like to record my thorough appreciation of the work that Mr. Sayer has been able, single-handed, to carve out for himself, although new to the subject. Two of his lines appear to me to be of special importance :—

"1. The accumulation of a mass of information on the trade side, for the benefit of those engaged in the sugar industry.

"2. His most successful propaganda work on the Coimbatore seedlings in Bihar."

In 1919, the Committee of the Indian Sugar Producers Association at Cawnpore represented that the time had arrived for some steps to be taken for the improvement and development of the sugar industry in India and for the announcement by the Government of India of the policy it proposed to adopt, particularly in its fiscal aspect. As a result of this representation, combined with the general awakening of interest in the subject, an Indian Sugar Committee was appointed to go thoroughly into the whole question. It is a matter of great regret that the major recommendations of that Committee have not been given effect to. Among these recommendations were :—

1. The creation of a Sugar Board.
2. The creation of a Sugar Research Institute with a net-work of sub-stations in all important sugar tracts throughout India.
3. A pioneer model sugar factory.
4. A Sugar School.

At present, the Indian sugar industry suffers from two main disabilities, the first agricultural and the second concerned with the manufacture of cane into raw sugar. The first is the extremely low yield of sugar cane per acre over large tracts of India. Improvements in yield can be brought about by wider extension of Coimbatore cane; this has been abundantly proved by the success achieved in Northern Bihar and part of the United Provinces. There is also great room for improvement in the standard of cultivation, manuring, etc.

It was the idea of the Indian Sugar Committee that research and propaganda in connection with sugar cane should be largely centralised under the Sugar Bureau or Indian Sugar Board which it was proposed to establish. The position has been considerably affected by the Reforms and the transfer of agriculture to ministerial control, but it seems to me that even with this administrative change there is considerable work to be done by the Central Government in the matter of the development of the sugar industry. The question is an all-Indian one, and it does not appear to me to be altogether impossible to develop a system in which the majority of the recommendations of the Indian Sugar Committee could be carried out by the Central Government, while local governments would assist in giving effect to the recommendations of this central research body. In most Provinces financial considerations and proper balance between the claims of sugar and other agricultural crops might make it impossible for particular Provinces to devote the time or money necessary for research into problems connected with sugar, although they might have staff and finance adequate to give effect to the recommendations emanating from the Government of India Central Sugar Research Bureau.

I venture to think that sugar is one of the matters for research which should receive attention from the Central Government, and that the general policy, both of research by the Government of India and of local research and propaganda in the Provinces, is one to be taken up by the Council of Agricultural Research, which has been recommended by the Royal Commission on Indian Agriculture. No doubt this Council in framing its policy will take into consideration the various recommendations of the Indian Sugar Committee and see how far these proposals can be fitted in with existing conditions.

If the Indian sugar industry is to be saved, the problems must be tackled at once and assistance must be given to Provinces where the crop is of importance, so that they can delegate officers to devote their whole time to work on sugar. There is no need to increase the present area under cane, or to infringe on areas at present utilised for other food crops. Already the area is nearly double what it need be if the sugar cane industry were efficient. If Java, with

450,000 acres, can turn out 2,300,000 tons of sugar per year, it is surely not too much to hope that India, with its three million acres, will be able to produce at least enough to meet her internal needs. I do not minimise the advantages which Java possesses as compared with India. The Java system permits of factory control of concentrated areas, and this undoubtedly makes her problem easier, but, apart from this, the outstanding position of Java in the sugar world has been built up almost entirely on the application of extensive scientific research to the problems of the industry.

In India it is not in most cases possible to obtain factory control of land and cane will frequently have to be collected from small and scattered holdings. At present most of that sugar cane is inferior, but if, as a result of research, better cane is available, we need have no fear of unwillingness on the part of the cultivator to take it up. Nor is it a matter of any great difficulty for a factory to work up a connection with local cultivators to ensure regular supplies. Scientific research and factory organisation are the key-notes to the solution of the problem.

Suggestions.

In conclusion, I may perhaps be permitted to indicate very generally the lines upon which I consider the problem should be tackled.

I repeat that in my opinion the limit of tariff protection has been reached. We must attack the problem fron the agricultural and manufacturing side. My suggestions are :—

(1) That the work of the cane-breeding station at Coimbatore should be continued and extended and that arrangements should be made to ensure continuity. Dr. Barber has gone and Rao Bahadur Venkataraman cannot go on for ever. A thoroughly competent botanist should be in training to carry on the work when a vacancy occurs. I say *thoroughly competent.* The only consideration that should influence an appointment to the staff of this station is that the very best man available should be secured.

(2) In Provinces in which sugar cane is of importance one deputy director of agriculture should be recognised as the provincial sugar cane expert and so far as possible his labours should be limited to the one crop. It will be his duty (*a*) to study the local canes and select the best of them ; (*b*) to make such arrangements as may be necessary for the careful testing of his own selected canes and of the Coimbatore canes and for the multiplication and distribution of such improved canes as may be recommended.

(3) While work in the Provinces must naturally be entirely under Provincial control, arrangements should be made for the closest collaboration between the Imperial sugar expert and Provincial officers working on sugar cane. The Central Board of Agricultural Research should be in a position to arrange the necessary links between Imperial and Provincial officers. It is of vital importance that there should be the closest relations between Coimbatore and

Provincial officers and exchange of visits between them should be encouraged. No obstacles should be placed in the way of the Imperial sugar cane expert and he should be encouraged to travel freely over India in order to keep in touch with the developments in the Provinces and to observe the behaviour of his selected seedlings under the varying conditions which will be found up and down India. I emphasise that to ensure success of the Coimbatore work and to guarantee its spreading all over tracts of India where Coimbatore canes are found to succeed there must be the closest collaboration between the sugar cane expert and Provincial workers. All petty jealousies must be sunk and all must work with a common aim.

(4) Where composite blocks of suitable land are available and where there are no local difficulties, large grants of waste land suitable for the cultivation of sugar cane should be given to groups or individuals who are prepared to erect a modern sugar factory. We cannot get away from the fact that the great factor in Java's success is that factories have control of the land and are both growers of the cane and manufacturers of sugar. Where, therefore, a similar position can be developed in India without interfering with the general interest of the community, the Government should have no hesitation in granting land on favourable terms to manufacturers who are prepared both to grow and manufacture sugar.

(5) It will be for the Council of Agricultural Research to decide whether a central Sugar Research Institute is required and whether the Government should set up an experimental sugar factory. Personally, I do not think that the latter is necessary, but the former might be the best and cheapest way of working out problems of general application connected with crushing, small power installations, fuel consumption, and the like, and also the innumerable problems connected with *gur* manufacture. Indian scientific workers could also be trained there.

(6) It will also be for the Council of Agricultural Research to decide whether the Sugar Bureau should be made permanent, and, if so, on what lines it should continue to work.

(7) Agricultural problems connected with sugar cane must be worked out locally in the Provinces, but a mycologist should be attached to the Coimbatore station, whose personal concern would be investigation of the diseases of sugar cane and whose services would be at the disposal of all Provinces. The Java industry was saved from complete ruin in 1884 by concerted scientific attack on the *Sereh* disease, which threatened to exterminate it. A similar calamity may strike India at any moment, and we must be prepared to meet such a possibility.

All over the world areas under sugar cane are increasing. Agricultural and factory efficiency are advancing in practically every country, and each year sees conditions for an inefficient industry made more and more impossible.

It is no exaggeration to say that no duty of any reasonable size could have kept the Indian sugar industry as it existed before the War alive at the present day. Its own inefficiency must have strangled it. In recent years there has been a stimulation of interest and efficient factories are springing up. Efforts should not be relaxed, and if there is a fixed determination to tackle the problem seriously there is no reason to despair of the future of the industry.

DISCUSSION.

Dr. C. A. Barber, C.I.E., Sc.D., Lecturer in Tropical Agriculture, Cambridge University, said he greatly appreciated having been invited to hear Sir James MacKenna's very able paper. He said "able" for two reasons, first of all because it was by MacKenna, and secondly, because Sir James had had unique opportunities of getting hold of the details of sugar industry in India on the higher plane, taking a large view. Personally he had for a long period been engaged in the humbler duties of trying to get to know all about the cane, trying to grow it, and trying to improve its yield of sugar. One of the subjects which had interested him greatly had been the origin of the sugar cane, and he would like to say one or two words on that point. When he had first started studying the sugar cane intensively, he had thought, as most others had done, that it was probably derived from the wild cane of which the lecturer had spoken, called *S. Spontaneum*; but the problem had got more and more difficult, until finally he had had to give it up The present general view was that the cultivated sugar cane had to be divided into two entirely separate classes of different origins. That was a recent view which was now generally accepted by students. He gave that as an addendum to the view which the lecturer had expressed, and which had been held at the time of the Sugar Committee. In the first place the North Indian canes were very different from the tropical ones. The North Indian canes were thin and hardy, had much fibre and little juice, although the sugar was sometimes very good. It was assumed generally now that these had arisen in India itself around the northern shores of the Bay of Bengal. It was almost impossible to conceive of the tropical sugar cane having arisen in India. Those who had tried to grow it there (except in the extreme south, and nobody claimed that it arose there), could definitely say that it was not likely that it would have occurred there first; and the general view now was that the tropical cane had arisen from an entirely separate form in the islands of Oceania, and especially New Guinea. He had always thought that New Guinea was the place to look for the origin of the thick canes, for the reason that a number of years ago the Australians in Queensland had sent over men to explore the country for sugar canes, and they had taken back an extraordinary number of different kinds, some of them better than the sugar canes which were then already growing. Anybody who knew the interior of New Guinea could quite see that there were no possible means of influence reaching it from India. With that view he concurred fully, and he might say that the United States had recently placed a large sum of money at the disposal of one of its bureaux—that of plant industry—in order to try and improve the sugar industry. An expedition had been to New Guinea and had just returned with a large consignment of those original canes. An interesting point about New Guinea was that every village had its own particular kind of cane; one had a red one, another a yellow, another a striped, and another had one with different bands of colour, which seemed to him to argue a very ancient tradition.

He need not say any more on that subject; it was a large one, but he thought he would bring the question of origin up to date so far as it had gone. It, of course, might be quite wrong, but that was the present view.

Recently he had been studying the factors involved in costs of producing sugar in some of the different countries of the world, with rather extraordinary results. Queensland was stated to take £25 to make a ton of sugar, in spite of lovely canes, including some of the New Guinea ones, and an excellent climate. The labour was very dear—17/- a day—because of the ideal of a White Australia. Cuba produced its sugar at from £6 to £7 per ton, but the labour cost was high—5/- a day. Java produced its cane at about £7 to £8 a ton. It had the cheapest labour in the world—10d. a day—except that of India, which was 4d. to 8d. a day; yet it cost India £11 to £15 per ton to make sugar. Labour, then, was not the only key to the situation. There were many other factors. One of them was that the factories in India were extremely small, though the actual manipulation in the factory had greatly improved in recent years. The factor, however, with which he personally was most concerned was connected with cane breeding, and its very great importance was illustrated by certain startling figures which he had come across lately. These applied to Java, which was the country in closest competition with the Indian white sugar industry. In 1912-13, with about 450,000 acres of land, they had produced about 1,300,000 tons of sugar. At that time it had been considered that there was no chance of much expansion in Java, because almost all the land fit for sugar cane and which could be released by Government for sugar cane growing, was already used for that purpose. There were two periods since then to which he would like to draw attention. In 1919-20 the figure had been 1,500,000 tons, and in 1923-24 it had been 1,700,000—much to the surprise of people outside Java. The second period was much more interesting. In 1926-27 the figure had been 2,300,000, and in 1927-28 it had been 2,900,000. The estimate for next year was 3,200,000. What was the factor? The factor was obviously connected with new kinds of cane. Java was the Mecca of cane breeding, and was raising new seedlings of better characters. A number of those improved seedlings had been developed in the first period of 1912-24. There had been also improvements in technique in the mills, in the manuring and in every portion of agriculture, but nothing to account for the increase in quantity produced per acre. In the second period, from 1926 to the present day, a strange new seedling had appeared under the name of "P.O.J. 2878." Hitherto they had specialised in Java, as they had tried to do in India, in finding cane seedlings particularly suited to different kinds of soil in different parts of the country. They had succeeded admirably, so that every estate knew just what kind of seedling was to be planted in each part of the estate. Now they had come across a cane which could grow anywhere, and the result of that was that all the former kinds were being scrapped. The new seedling was displacing the others, and it was calculated that in the next year—the present year in fact—it would fill the whole of Java. That, he took it, was a very strong argument in favour of pushing cane breeding to its extreme limits, as long as it was properly done.

Reference had been made by the lecturer to the number of acres devoted to growing the new canes at Coimbatore. He would like to give further figures indicating the spread which was now becoming rapid. Those canes had been released for trial in North India in 1918-19, and the period of trial had been reckoned to be from 3 to 5 years before it could be said that the canes were suited to North India. They had been evolved over a thousand miles south in tropical India, for the reason that the seedlings could not be got in North India because the canes did not

flower there. He had not been able to keep in touch with the increased areas very accurately, but casual friends had sent him statements from time to time. There was one definite statement, however, which he had got in print from Mr. Venkataraman. In 1926 Mr. Venkataraman stated that 24,000 acres were under the new canes, and that this area gave £100,000 profit to the cultivators. In 1927, which was about the period with which the lecturer dealt, there were 60,000 acres under those canes, and within the last few days he had received information that the acreage this year would be 150,000. Therefore there was an improvement, and he was glad to hear of it.

He desired, in conclusion, to express his great appreciation to the lecturer for the extremely kind manner in which he had referred to the work which he, personally, had been able to do.

MR. GEORGE PILCHER, M.P., said he was not an expert in the subject. His only qualification to be interested in it at all was that he had owned a few shares in one of the mills which had been established at the time of the renaissance about 1919-20. As one who took an interest in India's economics generally, he might make the rather obvious remark that sugar production did seem to offer a very great opportunity in the future if some of the recommendations of the Agricultural Commission were carried into effect. It seemed obvious that the Central Agricultural Council, if and when it was established, should turn to that great opportunity and make some effort to develop India's sugar possibilities. It seemed tragic that Java should come second in the rank of countries importing commodities into India mainly on account of her enormous sugar production, and that India should utilise her own sugar acreage to such relatively small advantage.

SIR HENRY STAVELEY LAWRENCE, K.C.S.I., remarked that the lecturer appeared to hold that the Government had done all they could to encourage sugar cane cultivation in India. That was a debatable point. The cultivation of sugar in every country in the world had been fostered by Government, and he doubted whether it had made its way in any country in the world without having been definitely fostered by Government. The lecturer would confine assistance by the Government of India to the agricultural and engineering side, but he had not given any reasons why he considered that it should not be extended to providing a sufficient tariff to give adequate protection to the industry. The tariff which had been imposed was much lighter than had been imposed in England to help the beet sugar industry. It was much lighter than that imposed in South Africa, where they had an effective protection against Java competition. The fact was that the Government of India had throughout maintained that their tariff was purely for revenue purposes, and had refused to admit that it was a tariff for protection. Figures had been given which showed that the importations had increased four-fold of recent years. He was told that the importations, almost entirely from Java, had doubled within the last year. It was an open question whether that was for the benefit of the sugar cane cultivator in India. It had been stated that the area under cultivation in India was 3,000,000 acres. Assuming that one acre supported a man with a family, that meant that there were 3,000,000 families dependent on the industry in India, which showed that it was a matter which should receive a great deal more attention from the Government than it had yet received. The mere fact that for over ten years very little had been done to carry out the recommendations of the Sugar Committee was sufficient to indicate that the economic considerations in India had not received their proper share of attention. The recent Royal

Commission had given their support to the recommendations previously made by Sir James MacKenna's Committee, and if any words from the Royal Society of Arts could help to stir the memories of the members of the Government of India, he hoped they would be forwarded and have that effect.

Mr. H. A. F. Lindsay, C.I.E., C.B.E., Government of India Trade Commissioner, said he had been a witness before the Sugar Committee when Sir James had been in the Chair, and he remembered the trying ordeal that he had gone through when Sir James had extracted every ounce of information out of him with the same efficiency as the most up-to-date sugar crushing machine. The point at which he himself had come into contact with the sugar industry lately was chiefly the commercial side. There was a tremendous fight going on at present between the cane sugar industry and the beet sugar industry. There was one interesting point in connection with that competition, namely, that the beet sugar industry was an agricultural crop, and therefore in the ordinary course if prices went against the grower he could shift on to some other crop ; he had usually some reserve to fall back upon, but in the sugar plantation industry one could not shift on to any other crop ; the land was laid out under sugar, the factories were laid out for sugar, and there was an enormous amount of capital locked up in the concern. In India the cultivation of cane-sugar was an agricultural and not a plantation industry. One difficulty in regard to India was that many of the factories were in close competition with each other. That might sound as if prices should be brought down in consequence, but that was not really the result, because where too many factories were found in a small area those factories had to compete with each other for their raw material, and therefore the tendency was for prices of the raw material to rise. Exactly the same situation was going on in the cotton ginneries in Kenya Colony. He thought the lecturer would probably find that Indian sugar factories had to pay high prices for the cane in the immediate neighbourhood of each factory ; hence the high prices of the refined sugar which they turned out.

Mr. J. C. Sinha said the lecturer had stated that the limit of tariff protection in the case of Indian sugar had been reached. Personally, he would like to express the opinion that the sugar tariff had not had a fair trial in India. The present 25% duty was a revenue duty, and, as such, there was no certainty that it would be continued for some time to come. It was, therefore, evident that Indian capitalists would hesitate to embark their capital in the industry. If the Indian Government had definitely said that the duty would be continued for a series of years, a different state of things might have resulted.

A protective tariff was not the only method for resuscitating the Indian sugar industry, but he refused to believe that it was not one of the methods. By means of tariffs the sugar industry in other countries had been stimulated. The lecturer had stated that the art of refining sugar in India was more or less a recent one, but as a student of history, he had read that very fine sugar had been produced at Bianah near Agra in the 16th century, and there was reference to the production of fine sugar at Ahmedabad in the 17th century. With regard to the competition between Java and India, it was interesting to note that one of the earliest references to the competition of Java sugar was to be found in a letter written to the Court of Directors of the East India Company in February, 1758.

Mr. F. H. Skrine, I.C.S. (retd.), said that although the lecturer had put forward several recommendations for the future improvement of the sugar industry in India,

there were two further ways in which the Government could assist, and which were not mentioned in the paper. One was co-operation. He had just returned from Ireland, and he had been surprised to find how, throughout the whole of the Irish Free State, co-operation had changed the position of the agricultural industry there. The second was by improving and standardising the production of the cane. It was extraordinary to see the present differences there were in the canes, and it seemed to him that the Government could render enormous assistance to the sugar industry in India if it established experimental farms for the raising of the best kind of cane, and distributing it freely to cultivators.

SIR JAMES MACKENNA, in reply, said that, as was so frequently the case, the discussion had been of very much more value than the paper. As the audience would have realised from the points that had been raised, the subject was one of enormous compass, and could be viewed from all sorts of angles. Bearing that in mind, he had decided that the best way to set the ball rolling was to be as general as possible; and that had had the desired effect. Sir Henry Lawrence was a determined Protectionist, and his views had been shared by other members of the audience. His own economic views happened to differ, and he would leave it at that. He would only ask those who held the view that the limit of tariff had not been reached, what tariff rate they would propose to suggest which would keep out Java's efficiency? The success of Java had been entirely built up on its efficiency. Notwithstanding that India's tariff barrier had been raised again and again against Java's sugar, steadily and annually Java's imports of sugar increased. Mr. Sinha's economic history was first rate. It confirmed everything which he himself had discovered in the process of writing the paper. With reference to Mr. Skrine's remarks, no one had been in closer touch with co-operation in India than he had himself. He was afraid, however, that in regard to economic and agricultural ills, co-operation was something like the blessed word "Mesopotamia." "Mesopotamia" had had the good fortune to have had its name changed to Iraq, and one wanted to introduce a new name for co-operation. Co-operation was the broad back on which everyone put their troubles. After two years of close study of the situation in India, his colleagues on the Royal Agricultural Commission sincerely hoped that co-operation would be able to shoulder the burdens which everyone was inclined to, and intended to, place upon it.

A hearty vote of thanks to the lecturer concluded the meeting.

MR. W. H. MORELAND, C.S.I., C.I.E., writes:—

I regret that I was unable to attend the recent meeting of the Society's Indian Section, or take advantage of Sir James Mackenna's suggestion that I should contribute to the discussion an account of some of the earlier stages in the efforts to modernise the Indian sugar industry. The Secretary of the Section has now asked me for a note on the subject, and I am glad to comply with his request, though I can tell only of ancient history—ancient as India now measures time.

What struck me most in reading a proof of Sir James Mackenna's paper was that it is now possible to talk of the industry without referring to religion: thirty years ago, religion either dominated or underlay the discussions on the subject. At that time it was almost universally believed that all white sugar made in factories, whether in India or elsewhere, had been in contact with animal charcoal or other products of the sacred cow, and consequently was a pollution to Hindus. The belief was not fully justified by the facts of the industry, but it existed; and

to contradict such beliefs directly is merely a waste of time. When, therefore, the flood of foreign sugar reached Northern India, the cries of the local industry were reinforced by a sentiment so strong that no Government would have been justified in disregarding it.

Preliminary investigations showed that the foreign sugar did not immediately threaten the producers of *gur* for comsumption, who had in their favour social habits of the type which changes most slowly. It was recognised that *gur* would eventually be affected, and some figures given by the lecturer suggest that this change is now in progress; but the social protection, so to speak, justified the view that the change would come slowly, allowing ample time for gradual adjustment.

The case was different with the important white sugar industry of Rohilkhand, which was threatened directly by the foreign supplies. This industry had one merit, in that it produced marketable white sugar to which no religious objection existed. In every other respect it was a thoroughly uneconomic proposition, based on inferior cane, wasteful of raw material, extravagant in labour at a time when wages were rising, and so tedious as to involve heavy interest charges. The foreign sugar was so much cheaper that in a free market it must have killed the local industry at once: the religious protection which the latter enjoyed gave it a breathing-space, but, unlike social protection, could not be relied on for long; and the question was whether that breathing-space could be utilised to put matters on a better footing.

This question had to be attacked simultaneously on two lines, the raw material, and the processes of manufacture. On the first line, a study of the indigenous canes were undertaken, directed to ascertain whether, by suitable treatment, they could be made to serve as the basis of an efficient industry. This study gave valuable, if negative, results. It proved that the indigenous canes were not good enough; and it led to the movement for establishing a cane-breeding station, which, as the lecturer has recorded, came into existence in the next decade.

As regards processes, the idea of establishing modern factories had at first to be ruled out. Sufficient capital could, perhaps, have been raised, but a quarter of a century ago neither business enterprise nor technical skill was available; while the religious objection to any sort of factory-made sugar was by itself decisive. An attempt was therefore made to improve the indigenous processes, so that, if possible, they might be placed in a position to compete with foreign sugar on less unequal terms. A model plant was worked out on these lines, and shown at work for some seasons. The essential features were the introduction of a centrifugal extractor to separate the molasses, and alterations in the boiling-pans, designed to reduce labour costs.

This process, which came to be known as the Hadi process, was a success and a failure. It was a success in that, given a degree of skill equal to that existing in the indigenous industry, it could turn out a marketable white sugar at a substantially lower cost than the indigenous methods. It was a failure in that eventually it did not commend itself to the men engaged in the industry; and it did not establish itself in Robilkhand, though various modifications of it are working in other parts of India. Indirectly—and this was its real value—it combined with other sources of enlightment to disintegrate the old popular view that any sort of factory machinery must necessarily produce a sugar offensive to religion.

This change in popular opinion in the North was the most remarkable feature of the opening decade of the century. It is scarcely too much to say that, about

the year 1900, a sugar factory was commonly regarded by those who had never seen one, as a place of horror, where, behind high walls, unspeakable orgies were celebrated with the blood and bones of the sacred cow. In 1910, it was found safe to exhibit at Allahabad a modern factory, unwalled, and with ample passages by which anyone who chose had access to every part of the machinery. Mixing with the stream of spectators which flowed for three months through that factory, from the mill where the cane was crushed, past the vacuum pan, to the centrifugals where the white sugar emerged, it was possible to say that the greatest obstacle to an efficient sugar industry in North India had disintegrated, and that the road was clear for men with the skill and enterprise needed to put the industry on a sound technical and commercial basis.

EXHIBITIONS OF APPLIED ART.

Arts and Crafts Exhibition Society. Burlington House.—The Arts and Crafts Exhibition Society has a membership of nearly two hundred. Its importance, potentially, is great; but one may safely say that it deserves all publicity on account of merits that have already appeared, not merely on the strength of hypothetical benefits that it is likely to confer on British industry in the future. The world, not least Britain and America, suffers from what Professor Saintsbury calls chthesophobia: fear of yesterday: as if traditional forms were like so many old-fashioned uncles and aunts. Inspired by those lovers of the past, William Morris and Walter Crane, the Society is not likely to show signs of a passion for senseless innovations; it does not do so at present, and one therefore has the pleasure of observing developments of proven styles, and is not faced by examples of cold craft, comparable to and worthy of an ectogenetically produced humanity.

At the same time it is quite clear that a diversity of visions are included within the pale of the Society, which is as it should be, and that we have not here simply an aggregation of skilled connoisseurs. Take the bookbinding section, one of the strongest at the exhibition. Two of the most beautiful books represent opposite poles of design. The one, "Daphnis and Chloe," bound in blue morocco by Elizabeth Pye, is essentially of the twentieth century; the other, a Communion Book, bound by F. G. Garrett in orange morocco with a design in gold, has qualities of simplicity and good proportion which might have been the product of, and have done honour to centuries past. Other admirable books are W. Moss' "Defence of Guenevere." B. H. Newdigate's "Omar Khayyam," and its smaller neighbour, W. T. Matthews' "Picture Book of Bookbindings." There is also fine printing to be seen, and among the outstanding book illustrations are some designs by Robert Gibbings, whose wood engraving is to-day justly celebrated.

The furniture shown is less good throughout than the book production, but a chest-of-drawers by Russell Workshops is almost very good and a wardrobe in walnut by Edward Barnsley has agreeable features. A group of horses carved in wych elm by W. G. Simmonds fails to convince one that here is wood suitably treated. As in the case of some of the illuminations exhibited, the special talent of the medieval craftsman is lacking; wooden figures without austerity are childrens' toys, and illuminations without that same quality are apt to be saccharine.

Though none of the pottery is inspired, some pieces are attractive. Kathleen Vowles has a Majolica pot decorated with pleasant colours, of which one, her green, is so good that it is a pity so many others are allowed to jostle it.

Like the books, the printed stuffs are mostly good. Here the influence of Morris is not seen; instead of patterns in his manner the artists have adopted designs of an

abstract, very civil, modest and modern kind with which it would be easy and pleasant to live. Enid Marx is an able designer; her printed linen, No. 342, might be taken as a good example of a good collection.

With his lead water heads S. D. A. Saunders has made a fine job of a comparatively small decorative possibility. Old drain pipes are sometimes an adornment to a house with which they are coeval; modern ones generally are quite ugly without gaining in efficiency.

The silver workers of the Society, among whom are such skilled craftsmen as Paul Cooper, show an interesting assortment of wares. Mabel Camwell's tea-pot is a success.

The architectural room has many drawings by the late Halsey Ricardo, whose use of coloured tiles, as on a large house in Addison Road, found a certain number to applaud. But neither this expedient nor the design of the house in question commend themselves to the present reviewer. The surface of a building is none the worse for a little weathering. The psychological reaction from tiles is like that from too much window space; they suggest infirmity in the structure and probably, in the long run, end by displeasing those whose imaginations they have at first stirred pleasantly. The less experimental designs of the late Ernest Barnsley are sounder, and based on a good tradition, that of the manors and cottages of the Cotswolds. Mr. Barnsley was also a designer of furniture, and a good example of his craft is on view.

It is impossible in a small space to draw attention to all the notable objects assembled at Burlington House for this exhibition. It must suffice to say that one cannot believe so much talent will not find means and ways of bringing an increasing influence for good to bear on British industry.

Brook Street Art Gallery. Exhibition of Hand-Painted Pottery by Alfred and Louise Powell.—It is now many years since the firm of Josiah Wedgwood gave Mr and Mrs. Powell the opportunity of co-operating with them in the production of hand-painted pottery. For Mr. and Mrs. Powell are not actually potters, though in certain cases the pots which they paint are thrown after designs submitted by them. In the majority of cases they choose pots made in the ordinary course of business which strike them as suitable for painting, and they return these to Wedgwood's for firing when they have worked on them. They are assisted in their studio by a score or so of girls; the present exhibits, however, being their own work.

This arrangement is clearly excellent; it is generally felt that in British industry a closer contact between factory and studio would be desirable, and here is an example of such co-operation which has been a *fait accompli* for hard on a quarter of a century.

As to the exhibits—they are various, both in form and quality. There are huge vases and plates, and smaller, utilitarian pieces; dishes, jam-jars, coffee-sets and so forth. On some there are patterns, pure and simple; on others patterns together with formal figures; on others again we find houses, landscapes or animals. It looks as if the minds and imaginations behind this very sound work were abandoned to a rather pessimistic eclecticism: so many things are tried—and indeed brought to a satisfactory enough conclusion. An effort has been made to cater for a variety of clients with diverse tastes. Certainly, whoever has the taste to buy the charming jam-jar with its mauve Morris-like pattern of boughs and birds will not appreciate to an equal degree the heraldic plate which looks down from a neighbouring wall.

On the whole where Mr. and Mrs. Powell have confined themselves to patterns on conventional lines they are more successful than where they have given reign to their

inventiveness—influenced as they no doubt must be by a public taste that does not maintain a fair average. Their realistic landscapes and fanciful picturesque vistas, their angular hinds and modernist figures, though very clever are not entirely satisfactory. Painting *ipso facto* seems to destroy the intrinsic charm of the wellknown Wedgwood surfaces.

But there is a world of difference between the better work here displayed, which shows both taste and skill, and the tiresome painted pottery that is being produced by less experienced craftworkers in many parts of the country to-day.

COLNAGHI'S GALLERY. Exhibition of Work of Present Day Potters.—Colnaghi's exhibition embraces a wide range of work. Some of it is of that luxuriant, sentimental kind that finds favour in a certain class of prosperous drawing room, where it readily evokes the luscious emotions sought by the more indigent at spectacular films.

Take the groups called "Leda" and "Pharoah's Daughter," by G. Nicholson Babb. The fluency, the pseudo-artistry of such pieces is all too striking; yet they are æsthetically meaningless; conceived in an Albert Memorial spirit. Their sophistication is a pretence; they are skilled craftwork thrown away.

No less clever, no less attitudinising, and even more expensive are the figures by G. Parnell: as, for instance, "The Little Lone Shepherdess," fifty guineas; "Ripe Speragas," thirty-two guineas. There is a streak of devitalised romanticism in some people which enables them to take pleasure in work of the kind.

S. Fox-Strangways shows nine sets of tiles. She is straining in the right direction; her colours are good, her designs are almost good. Perhaps she is a little between two stools, uncertain as to how she should compromise between natural forms and more abstract patterns.

Pleasant shapes and surfaces are achieved by D. K. N. Braden and K. Pleydell-Bouverie. There is a homeliness about their work which is unaffected and agreeable. Mr. Bernard Leach tends to have good shapes and unalluring surfaces, while it is the other way about with L. and W. Norton, who have hit upon a number of surprising bulges with no discernible significance.

P. Simpson is another mistress of the opifact—the work of luxurious ostentation. One is inclined to ask whether her talent would not find more satisfactory expression in silver work. Her ingenuity, indeed her *finesse*, is thwarted by a medium which tends of itself to emphasise extremes. An earthenware jar is ponderous; a Meissen shepherdess too delicate to live. Part of an artist's inspiration consists in measuring the extent to which an admixture of his human individuality should be allowed to bring out the natural characteristics of his medium. If virtuosity in the man is a doubtful good quality, virtuosity in the material is directly unpleasant. There can be no self-determination in the inanimate world.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

THURSDAY, DECEMBER 27..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—Waves." (Lecture I.)

SATURDAY, DECEMBER 29..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—Signalling in Air and Water." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

DR. MANN JUVENILE LECTURES.

Under the Dr. Mann Trust, CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, will give two lectures for children on " Ships and Lighthouses " at 3 p.m. on Thursday, January 3rd, and Thursday, January 10th. The lectures will be fully illustrated by lantern slides.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. A few tickets are still available and Fellows who desire tickets are requested to apply to the Secretary at once. Tea will be served in the library after each lecture.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, NOVEMBER 27TH, 1928.

SIR THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in the Chair.

THE CHAIRMAN, in introducing the reader of the paper, said that most of those present whose work had been dependent on previously made topographical maps had acquired by superficial observation the impression that the professional surveyor was a man of very conservative habits. To find, therefore, a distinguished member of one of the two or three most distinguished Surveys of the world ready

to take up a system which was so radically different from established and orthodox methods of survey showed, at any rate, in the first place, that they might be quite wrong in regarding surveyors as conservative, and, in the second place, which was much more important, that there must be something fundamentally valuable in the new method of attack from the air. The surveyor was forced to adopt methods that appeared superficially to be conservative. His work was necessarily systematic, being preceded by the determination of base lines with a precision that few map users ever understood. A series of elaborate, expensive, and time-consuming operations were consequently necessary before the surveyor could ever show the patient map reader any visible results for his work. To undertake a survey by photograph seemed also at first sight a radical departure from standard methods, and then to use a rapidly-moving aeroplane as a camera carrier added to their prejudices and other grounds for scepticism in regard to the reliability of such methods for precision of measurement. Nevertheless, developments which had occurred during the past few years, almost entirely since the war and as the result largely of methods forced on us during the war, had changed the camera from an instrument which was used merely to give a superficial impression to one which could be relied on for quantitative measurements. Most of the audience would therefore listen to the paper about to be read with critical interest. Col. Crosthwait's account of that new method would be, to those who had been brought up in the old school, something of an awakening, and he had no doubt at the end of the lecture they would be convinced that the camera could be made to do serious work, recording far more about the contents of a country than its mere topographic outlines. To an empire like the British Empire, including larger areas than any other empire of lands which were covered by an almost impenetrable jungle, the adoption of survey instruments that could be carried freely in the air became of especial value. It removed one of the most serious obstacles which had hitherto delayed the development of many of the natural resources of the Dominions and Colonies. That old Society, in whose lecture hall they were, had been, for some reason which it was unnecessary to investigate at the moment, inspired always with the spirit of the pioneer. It had had the luck or the genius to discover early in their development new methods of work, and at some future date he had not the slightest doubt that the record of the present meeting would be turned up by the historian as one of the milestones in Empire development. He left the audience to judge from Col. Crosthwait's lecture whether or not that prediction was likely to come true.

The following paper was then read:—

AIR SURVEY AND EMPIRE DEVELOPMENT.

By Colonel H. L. Crosthwait, C.I.E., R.E. (rtd.)

By way of introduction, I should like to say how appropriate it is that a paper connected with Survey and Maps should be read before the Royal Society of Arts. Perhaps it is not generally known that in order to encourage map-making in England, this Society offered premiums and medals for maps of the counties of England as far back as 1759. These awards only ceased about the year 1802, when the first one-inch maps of England, brought out by the Ordnance Survey, began to appear. I believe that awards were given for

the maps of some thirteen counties of England, so that this Society already saw the advantage of maps long before those in authority did, as the Ordnance Survey really dates from 1783, when the triangulation of the country, on which the topographical maps depend, was begun, with the measurement of a base on Hounslow Heath by General Roy. That was 24 years after the Society first began to offer awards for maps of England.

The last time I had the honour of addressing this Society my subject was the Survey of India, and dealt with normal methods of ground survey. That was nearly five years ago, and even in this short time things have advanced a great deal, and now I wish to speak to you about air survey and its bearing on Empire development—that is to say, the photographing of the ground from the air. From such photographs, in combination with points fixed on the ground, maps can be made, and also a great deal of other useful economic information can be obtained.

Mr. Amery, in his very interesting address to the last Imperial Conference, referred to the necessity for the scientific development of the almost unlimited resources of the Empire. We have heard a great deal lately about "buying Imperially," but we cannot buy Imperially until the Empire produces what we want in such quantities as will satisfy our needs. Experts tell us that, since the Empire possesses every variety of climate and soil, it is possible to produce, within its limits, everything we could possibly require; yet, according to the latest returns, only about 38 per cent. of the total imports of food stuffs and tobacco into the United Kingdom are derived from Empire sources. It seems, therefore, that there is still very considerable room for the development of our resources before the Empire can nearly supply all we want to take. This can only be done by bringing into production those large tracts of land which now lie idle, and which, if worked, would provide occupation for a large proportion of the surplus population of the older, overcrowded countries. It is indeed extraordinary that we should hear so much of making our Empire self-supporting while comparatively so little is being done to ascertain the possibilities which lie dormant in that Empire.

As an essential preliminary to economic development maps are necessary. Without them we cannot really begin to gauge our economic resources in forests, minerals and agriculture, nor can we properly allot areas to those who are anxious to occupy them, or tackle those engineering problems which go hand in hand with economic development, such for instance as the construction of roads, railways and irrigation works, and the investigation of hydro-electric schemes.

Without maps the overlapping of boundaries is inevitable, eventually leading to litigation and other inconveniences, with consequent waste of money. Surveys and maps should precede development and not follow it, if it is to be efficiently and successfully carried out. Unfortunately, this is a truth which does not always impress itself as much as it should on the official mind, though

there are exceptions. We can only suppose that this is due to the fact that expenditure on survey does not give a direct and immediately self-evident return. To grudge this expenditure is like starving a business by not supplying it with sufficient capital to carry it on at a profit. The Government which has a record of proper surveys and maps, and knows what it has to offer, is much more likely to attract immigrants and capital than one which can only supply imperfect information concerning its own resources.

The total area of the British Empire is nearly 14,000,000 square miles, and if we consider a country as *surveyed* if it is covered by ½in. to the mile or larger scale maps, executed on scientific lines by an established survey department, then we find that only about 20 per cent. of the whole area comes within this category. These figures show how little has been done As an instance of our omission to map our own colonies, we have been in occupation of Jamaica since 1655, just 273 years, yet there is not a single map of the island which is of any value. I believe I am right in saying that the only considerable unit of the Empire which nearly fulfils the conditions I have just laid down, excepting of course the United Kingdom, is India. I may say that in the Colonial Survey Committee, we have an advisory body which strongly advocates the necessity for Empire survey. Its annual reports are most instructive, if not very pleasant reading, only because they show how little has been done.

I propose to try and indicate to you in what ways aerial photography can assist towards the scientific development of the Empire. One great disadvantage of the production of maps by normal survey methods is its extreme slowness. Some officials may hesitate to launch a scheme which will not be completed in their time. There are certain to be other rival schemes which will mature much sooner; it is only natural therefore that they should be favoured. This particular drawback, however, is fast disappearing, as by the use of air photographs it is possible greatly to speed up the mapping of any given area. The photographs can be taken at the rate of some 80—100 square miles a day, which means that we have down on paper all the topographical details of the ground in an extremely short time.

I do not mean to say that all ends there. Points have to be fixed on the ground in order to form a framework to control the photographs which have been taken from the air, both as regards planimetry and height. The extent of this framework depends on the nature of the country under survey, but certainly much less ground work would be required than in the case of normal survey. Then the photographs require a certain amount of interpretation, object names have to be collected and, of course, maps have to be drawn and printed embodying the detail derived from the photographs after it has been duly reduced to the proper scale. But all this work progresses very rapidly once the photographs are taken. From the fact that the photographs are taken from the air, it is not so material whether the country would be classed as easy or difficult for normal methods of survey. For instance, it is just as easy to

photograph forest country from the air as it is to photograph open spaces. The air method also involves a minimum amount of work on the ground as the photographs themselves provide all the topographical detail, so that in unhealthy areas the ground staff is reduced to the lowest possible number, and remains for the shortest possible time in the locality, most of the work being done in the office.

Let us now consider in general terms how this air survey is carried out. When it is decided to undertake the survey of any given area, it would be

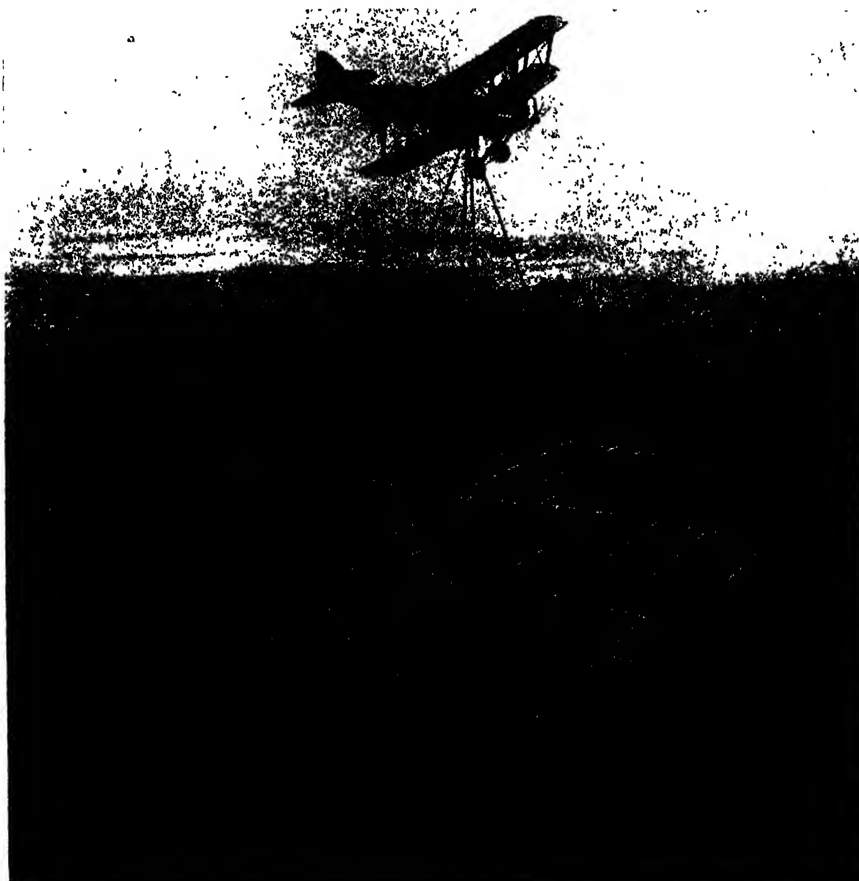

FIG. 1—Aeroplane taking overlapping photographs.

divided up into suitable sections. These would be covered by vertical photographs taken from an aeroplane flying over the sections in parallel straight lines. A specially designed, electrically driven, automatic camera is used for this purpose, an example of which, made by the Williamson Manufacturing

Company, is on view. It is known as the "Eagle" camera. These cameras, using films giving a picture 7in. x 7in., are capable of making 100 exposures on a single roll. The photographs would be taken with a 60 per cent. overlap in a forward direction and about a 30 per cent. overlap in a lateral direction, so

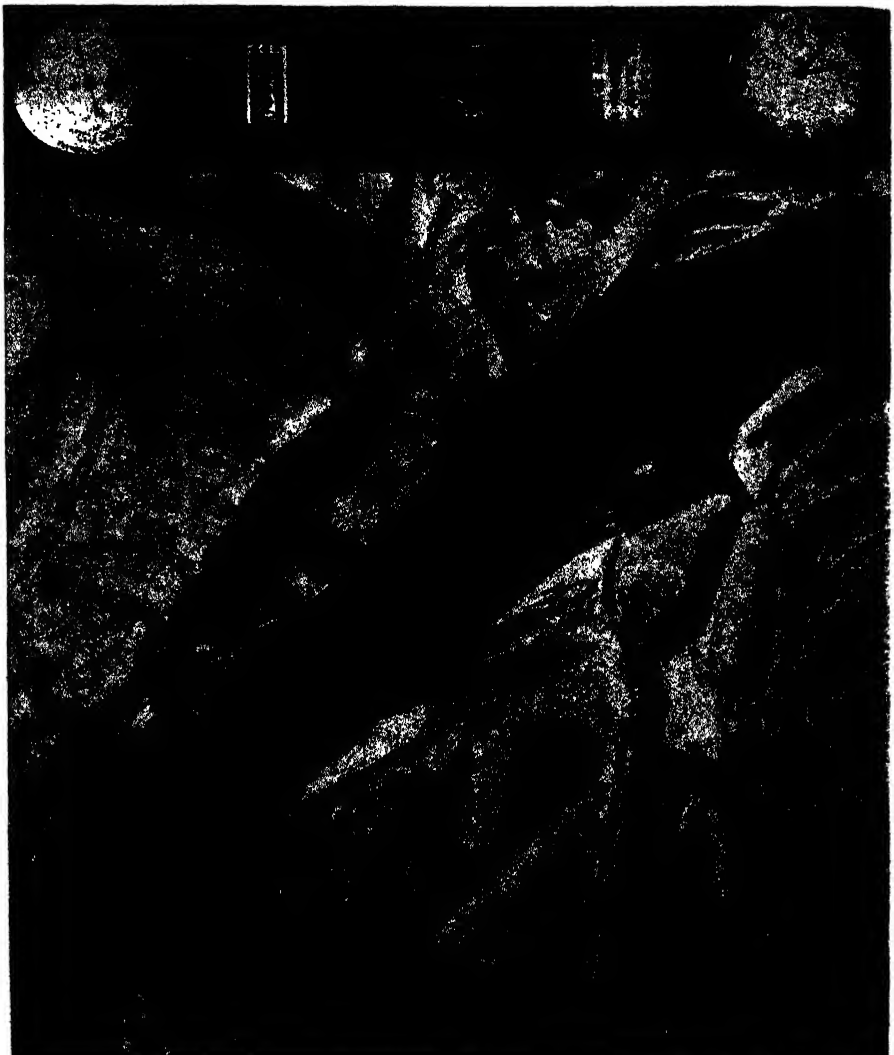

Fig. 2.—Single photograph showing instruments.

that the whole area would be covered by a series of overlapping photographs forming parallel strips which themselves overlap with neighbouring strips. Figure No. 1 shows in diagrammatic fashion how this is done. Figure No. 2 indicates what the photograph as taken looks like. When the photographs

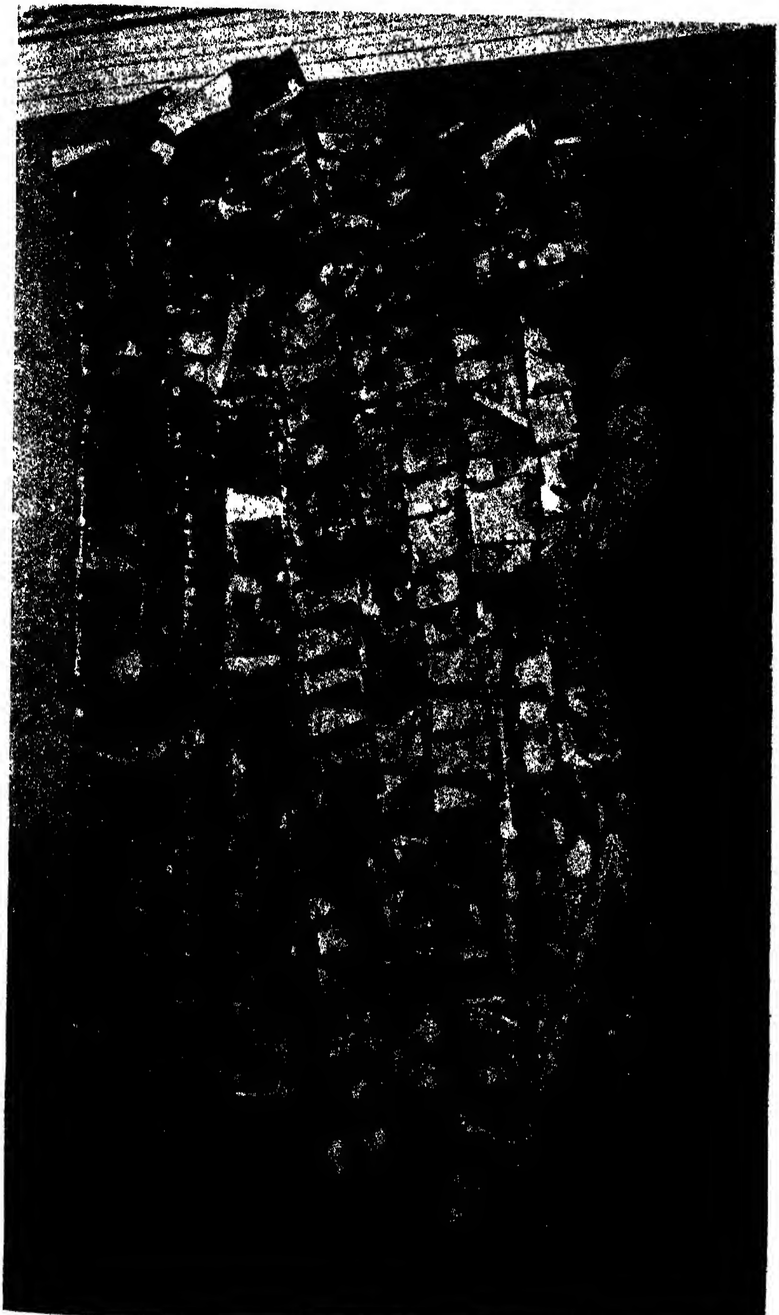

FIG. 3.—Joining up photographs to ascertain if whole area has been covered without gaps.

FIG. 4.—Plotting maps from aerial photographs.

have been developed and prints made in order to ascertain that the whole area has been covered without any gaps (see Figs. 3 and 4), they are then roughly joined together in conveniently sized sections and are given to the field surveyors, who fix suitably placed points for purposes of control, which can be easily recognised both on the photographs and on the ground. They also classify objects such as roads, etc., interpret any doubtful items of detail and collect the object names required for the final map. This fixing of points on the ground can be done by triangulation if the country is suitable, but often areas selected for air survey are wooded, intersected by waterways, or otherwise difficult and expensive to deal with by ordinary methods, so that it is now usual to fix points by astronomical observations, that is, to determine their latitude and their longitude by wireless time-signals. This has been made possible by the broadcasting of Greenwich time-signals which can be picked up with suitable apparatus in any part of the World. This process, unlike triangulation or other normal methods, does not require the expensive and slow clearing of lines for the surveyor. In this connection, a comparatively new instrument, of French invention, has come into use for finding both latitude and local time in one and the same operation, called the Prismatic Astrolabe, an example of which, modified by Mr. E. A. Reeves, is here for you to see, made by Messrs. Casella. There are also specimens of survey wireless time-receivers made by Messrs. Marconi. At the same time, the ground surveyors also fix a number of heights in suitable places for the eventual contouring of the finished map.

In the first instance, heights would be fixed by means of batteries of aneroid barometers, an example of which is kindly shown by Messrs. Negretti & Zambra. Field readings would be controlled by continuous base observations. A new kind of aneroid known as the Paulin Barometer is also shown. This barometer shows considerable promise, though we have not yet tested it out. From the photographs thus obtained, in combination with the ground control, both as regards position and height, maps can be produced.

Another method has also been employed; instead of taking vertical photographs, oblique photographs are taken in such a manner that the horizon is visible in the picture.

Perspective grids are then applied to these photographs and the detail is transferred on to squared paper as illustrated in Fig. 5. This method is not suitable to every class of country. The ground should be flat and the horizon must be visible when the photograph is taken. It is a method which has been largely used in Canada, where the country is flat and particularly suitable, and the topographical features are large, and where maps on a small scale only are required. But there is no doubt that it has great possibilities in new countries where large areas have to be surveyed at a cheap rate, and where the ground is favourable.

The stereoscope, an example of which, made by Barr & Stroud, is on the table, is an instrument which has proved of the greatest value in plotting

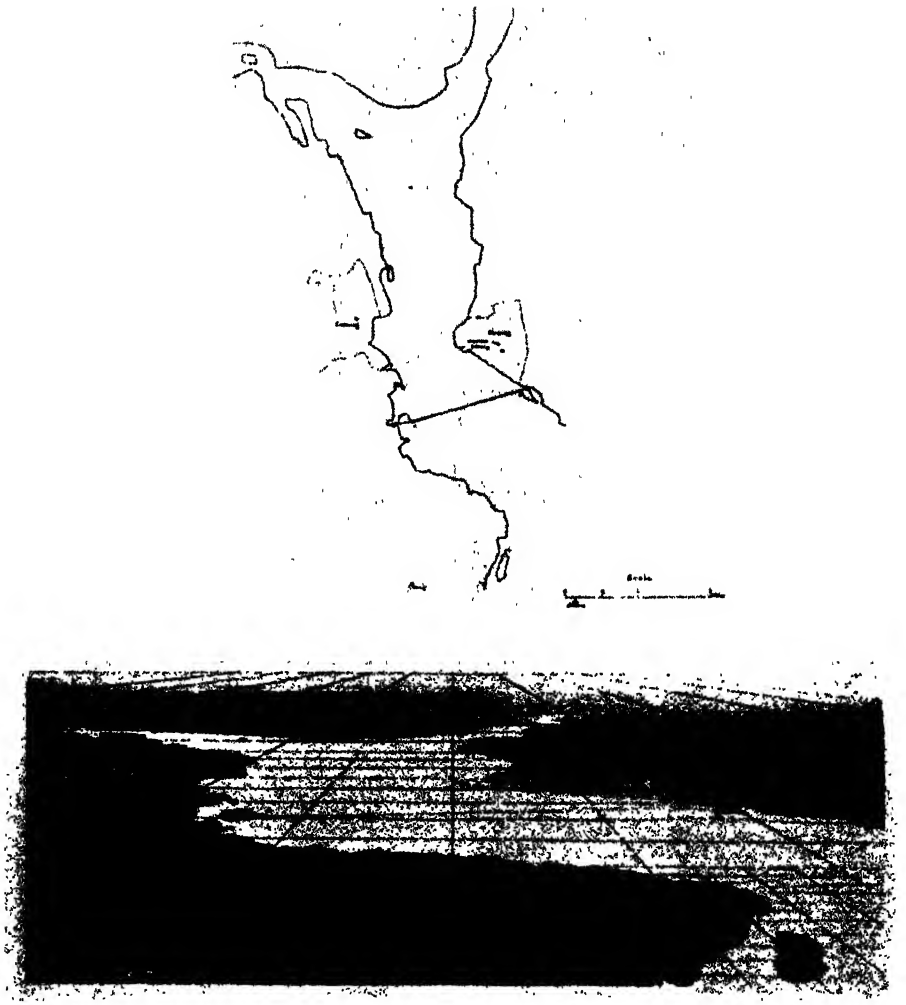

Fig. 5.—Oblique photograph and resulting map.

and contouring maps made from air photographs by a method sucessfully developed by Capt. Hotine, R.E. Pairs of photographs which are taken with a 50 per cent. and more overlap, can be used for examination in this instrument, the effect being that we see a model of the ground in perfect relief. It is astonishing how much detail which is missed in an ordinary photograph can be seen. Besides its use for mapping, the stereoscopic viewing of vertical photographs has advantages for engineering purposes not afforded by any other method. The engineer can examine at leisure in his office what is equivalent to a model of the ground in which he is interested exact

in every detail. It is safe to prophesy that in the future every engineering scheme of any importance will have the site with which it is concerned photographed from the air for stereoscopic examination.

Let me indicate shortly some of the other uses to which air photography may be put in connection with economic development.

Air photography is extremely applicable to the location of railways in undeveloped or partially-developed countries, where either no maps exist or are on a small scale only, the object being to assist the railway engineer to decide upon the best and most economical line to construct. The faulty alignment of a railway may be the cause of very considerable and continuous loss to the owners and to the country through which it passes. While on this subject, I should like to quote the remarks of a distinguished Colonial Governor, who is also a very experienced surveyor, during a discussion following a paper read last year in this theatre, though not before this Society, but before the Institute of Aeronautical Engineers. He said :—

> "Up to the present our tropical Colonies have had to make shift—when "we have had to make roads, we have made them whether a contoured map "existed or not ; the same thing applied to railways. The other day we spent "one-and-a-half millions in straightening out the railway between the coast "and Coomassie, which had been constructed before a map was made. If "you can get a photographic map first, you are going to save yourself literally "hundreds of thousands of pounds in road or railway construction, but if you "are going to conduct that survey by working through forests it is going to take a "long time : on the other hand, if your air survey company can get a decent "photographic contoured map of the country, it will be a good and quickly "made guide, and will greatly help the Colonial Government of a tropical country "in its work of developing railways and roads."

About a quarter of the sum wasted on this particular railway, owing to an attempt to develop before maps were made, would have more than sufficed to survey the whole of the colony and to provide it with a set of maps which could have been used, not only for railway and road construction, but for general economic and administrative purposes. It is an example of the uneconomic result of *not* mapping before development. It should be mentioned however that this railway was made before the days of air photography.

This question of the location of railways by means of air survey is so important that it is worth a few moments' consideration. For purposes of illustration, let us suppose that three possible routes or alternative alignments for a railway have to be examined, with a view to deciding which is the most suitable from an economic and engineering point of view. Each line would be photographed from the air with a 60 per cent. overlap. Mosaic strips would be made, brought to scale, and adjusted by making use of all existing control. These strips, together with a set of contact prints, would be submitted to the Chief Engineer for examination and viewing in the stereoscope. From such examination he would be able to decide which appeared to be the most suitable one of the three routes. Having done this, he would order it to be contoured. The

photographs of the route would then be taken in hand by a small ground party, which would determine heights at points selected as being the most suitable for stereoscopic contouring. This would be done by men walking over the ground with a battery of aneroids such as I have already mentioned. They would also provide any extra ground control which might be required for scaling the strip. Using these heights, the route would be contoured by means of the stereoscope, and again submitted to the Chief Engineer, who would most likely be able to decide the line to be finally surveyed by the railway field party, using normal methods. Alternatively, the Chief Engineer might order the contouring of one of the other routes before coming to a final decision. The determination of the necessary heights for purposes of contouring can be very rapidly carried out in the field. The photographs, aided by the stereoscope, would also afford a great deal of information regarding bridging and other engineering works which may be necessary. It is estimated that by this means the reconnaissance location surveys, for the purpose of discovering the best route, could be carried out in one quarter to one-fifth the time required by normal ground methods, and at much less cost.

Among the engineering uses to which air photography can be put is the investigation of water power development, water storage for irrigation purposes, and allied engineering projects. It has been found that the feasibility of a water power scheme, involving storage of large quantities of water, necessitating the submergence of considerable areas of land, could be ascertained from the study of air photographs in the stereoscope, with a very small amount of ground work. I do not mean that no field work whatever would be required, but the stereoscopic study of overlapping photographs will reduce it to a minimum and enable the engineer to make his preliminary report after only a few measurements taken at ruling points. This means that the preliminary reports can be prepared in a much shorter time and at less expense than has hitherto been the case. The method assumes a special importance in situations difficult of access on the ground, in view of the fact that so many hydro-electric schemes are often situated in such places.* The photographs taken for the preliminary investigations could be utilised for the final plans merely by adding to the ground control—it would not be necessary to re-photograph. As an example of the practical application of air photographs to schemes of this kind, I may instance the case of a power scheme connected with Lough Neagh, in Ireland, the perimeter of which, 85 miles in length, was photographed by Aerofilms, Ltd., in a single flight, showing the height of the water at a certain flood level, and the land that was submerged. From these photographs, and the detail common to them and the Ordnance Survey maps, it was possible to lay down on the map the water level contour before it had time to vary, with the least possible delay and at a comparatively small cost. Instances of this kind often crop up when cases have to be prepared,

*See Report Canadian Air Board, 1927.

generally in a hurry, for presentation to Parliament. The location surveys for electric power lines and pipe lines can also be rapidly carried out from the air.

With regard to the use of air photography in relation to the economic development of new countries, Mr. R. Bourne, of the Imperial Forestry Institute at Oxford, has recently brought out a most interesting and important pamphlet dealing with this subject, to which I should like to draw special attention. In it he describes the results of his investigations in Northern Rhodesia, using air photographs which were originally taken by the Aircraft Operating Company's expedition in that country, under Major C. K. Cochran-Patrick, D.S.O., M.C., for the Rhodesian Congo Border Concession, Ltd., who kindly allowed the photographs to be used. To quote from this pamphlet, he says "The future prosperity of the British Empire depends a good deal upon the economic development of the agricultural, forest, and mineral resources of the Colonies, India, and the Dominions." His experience in Rhodesia leads him to the conclusion that an air survey can contribute towards economic development under the following heads, namely, by indicating :—

"(i) The geological formations in sufficient detail to serve as the basis for the "production of geological maps.

"(ii) The localities in which mineralization is likely to occur.

"(iii) The zones in which, as a whole, the soil conditions are exceptionally "favourable for agriculture as practised (*a*) by the European and (*b*) by the "native.

"(iv) The zones in which the forests ought to be reserved for commercial or "protective reasons.

"(v) The correlation existing between the tsetse-fly and climate, geology, "soil, vegetation, fire, game, and man.

"(vi) The alternative alignments for the further development of roads and "railways, with a view not only to economy in construction and maintenance, "but also to the tapping of potentially productive areas."

This list gives plenty of food for thought for those who are interested in Colonial development, both Government officials and private individuals, and indicates the importance of the weapon which air survey has placed in their hands. Fig. 6 shows a photographic strip of country on which the forests have been classified by Mr. Bourne.

It would be impossible to deal with all the various applications of air photography such as the revision of existing maps on which the Ordnance Survey has been carrying on experiments during the last few years. Local Councils have also used it for bringing up-to-date maps for housing and similar schemes.

At the present time we are carrying out an extensive survey on a large scale of the City of Rio de Janeiro, in Brazil, for town-planning and extension purposes.

The question may well be asked what influence will this new method of photographic surveying have on the form of the map of the future. Is it not possible that the map of the future will be a photographic representation of

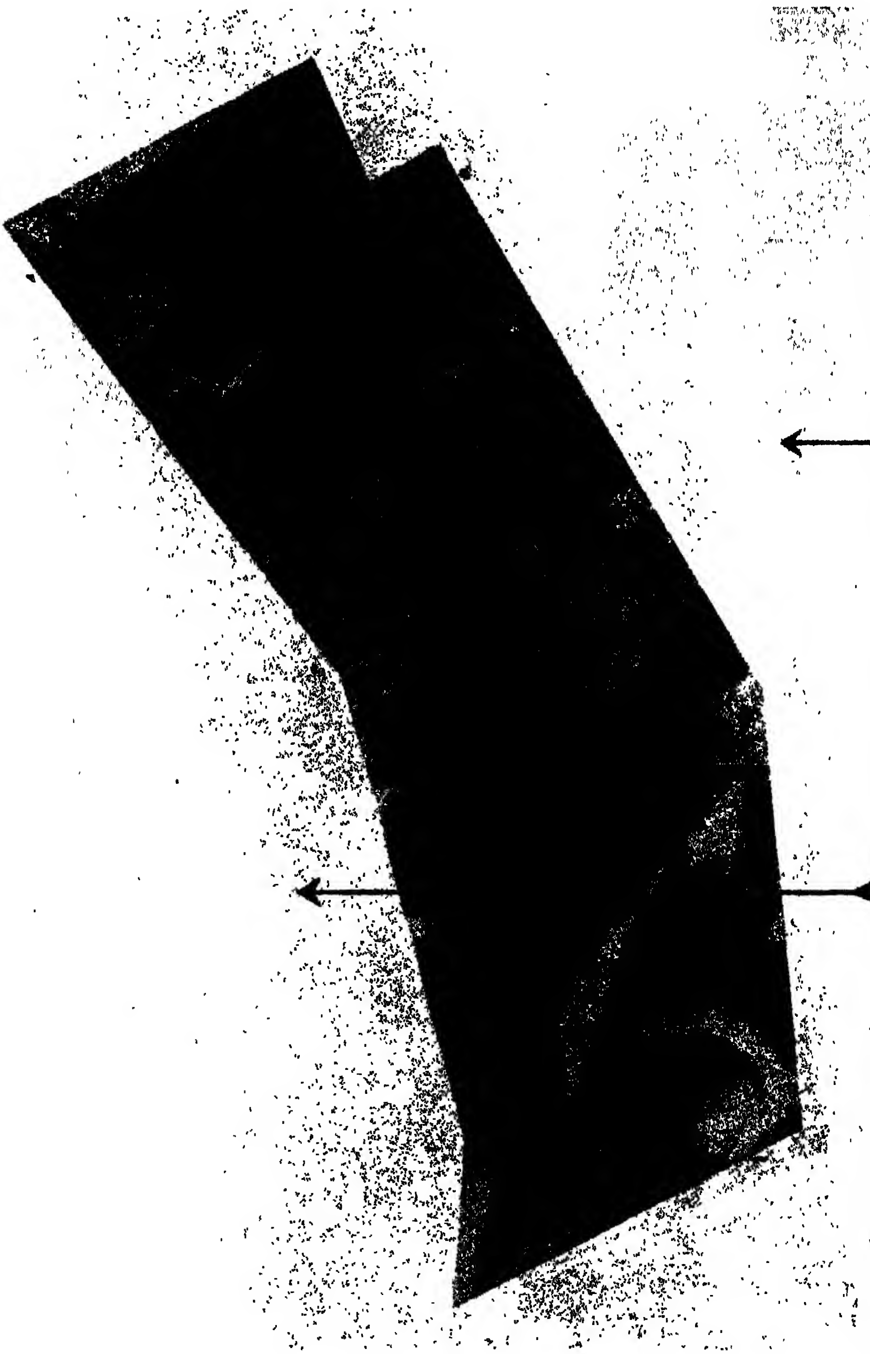

FIG. 6.—Classification of growth by means of aerial photographs.

the ground, on which have been surprinted certain conventional signs and colours, so as to indicate what the objects are, and to make it easier to read? For instance, we can imagine a photographic map on which the roads had been classified by means of some conventional sign or colour, just as they are on the ordinary maps to-day. I believe that such maps would be of very great interest and practical value, when applied to suitable ground. One difficulty about such an arrangement would be the reproduction in large quantities. This is a question for the consideration of the expert map-printer and process worker. But it certainly seems to me that there are possibilities in that direction worth considering. We are trying experiments at present with a photographic map of London.

Only the other day one of our most experienced surveyors made the following remark, which I think is worth repeating. He said: "I can recall no more striking lesson from all my experience than that the surveyor in laying his plans should always take the longest view. I think this is the more important because experience also shows that those whom the surveyor serves seem to have, in respect to maps, an inveterate propensity for hand to mouth arrangements."

It is this short-sighted hand to mouth arrangement which is the bar to all real progress of economic surveys intended to assist development.

For the survey of a country to be really effective, and promote the interests of development to the fullest extent, it is necessary that all government departments should co-operate so that all the information required by each one of them should result from the survey.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said he felt sure that the audience would agree with his statement at the opening of the proceedings that the present meeting would be one of the milestones, not only in the history of the Society, but in the development of a new form of technology. When he read the proofs of the lecture he felt that he would have some nervousness in expressing the opinion that, as an essential to economic development, maps were necessary. He would just as soon think of going before a meeting of the Public Works Department and saying that, before starting a building, an architect's plan was necessary. The author went on to show that in Colonial development it was necessary to abandon the foolish policy of development in advance of the maps. The reader of the paper had referred to the striking case of Jamaica. He (the Chairman) thought it ought to be said, in fairness to those officials who worked in the West Indies, that there were instances of West Indian Colonies shewing enlightenment in the matter of map-making. Trinidad was warned before the war, owing to oil development, that accurate maps were necessary, and as soon as possible after the war that question was taken up. A party of Royal Engineers, under Captain Lathom, was sent to undertake the survey of that island and Tobago, on a scale of 1 in 50,000. That map had been carried on by the remarkable industry of Mr. McGillivray and was now ready for publication; as a matter of fact he believed some of the sheets

had already been published. But that was an outstanding spot in the West Indies, and among the Colonies generally what Col. Crosthwait had said in criticism of the policy that had existed was by no means exaggerated. He recently turned up the Blue Book containing the Report of the Hon. E. F. L. Wood, M.P. (now Lord Irwin, Viceroy of India), who visited the British West Indies at the end of 1921 as Under-Secretary of State for the Colonies. He reported very favourably on the potentialities of British Guiana, the following being a very striking extract from his Report :—

> "British Guiana is a vast virgin forest country with resources in land, timber, minerals and water-power lying idle and unharnessed. It is part of the great fertile belt of tropical South America awaiting development. Although as large as the whole of Great Britain, it has a population less than that of Hertfordshire, and a cultivated area about one-fifth of the size of Kent. The present cultivated area consists entirely of a strip of coast-land varying in depth, but not usually, except along the fringes of the rivers, extending more than five or six miles inland. . . . As the interior is largely unsurveyed, it is impossible to speak with certainty as to the quantities of these materials that may exist. There is no doubt, however, that the potentialities of the hinterland are great."

When it was realised that British Guiana has been in possession of this country since 1814, and that the report he had quoted represented the results of British development work, it indicated that the survey of the country had been greatly neglected. Only 95 miles of railway had been built during the 114 years British Guiana had been in the possession of this country, and those facts showed how little this country knew of its possessions and how little it had done in this instance to develop the land that had been entrusted to it. The lecturer was perfectly right in drawing attention to that phase of work in Colonial development, and still more he was justified in giving a warning that survey should come first. If the survey had been undertaken no doubt development would have proceeded on quite different lines. The reader of the paper had produced a new instrument for surveying which had not the objections of the old one. He saw a good many gentlemen present who had suffered, as he had done, by attempting to do survey work in thick tropical jungle, where every foot of the ground had to be cut in front in order to make a line. It was well known how laborious that work was in the tropics, but the reader of the paper had shown that at last an instrument had been made which was not a mere toy, which could be used for serious quantitative survey work, and which could overcome the great difficulties that had hitherto been experienced. The method that had been described so graphically was one to which he thought they were largely indebted to archæologists. Far away back in the eighties, Major F. Elsdale experimented with balloons in the hope of detecting archæological remains; and subsequently Mr. Wellcome used anchored kites on the Upper Nile to photograph, by vertical photographs, the remains which he had been working on in that area. Probably the next important step in that direction was undertaken by Col. Beazeley in Mesopotamia in 1917. Col. Beazeley then showed that, from vertical photographs taken from aeroplanes, he obtained outlines of ancient cities, with the ordinary arrangements of streets and houses, in a way that never was suspected by ordinary observation on the ground. Many present would remember the excellent work done after the war, he was going to say accidentally, but certainly surprisingly, by Air-Commander Clark-Hall and Flight-Lieut. Haslam in Hampshire. By air photographs they discovered traces of ancient workings which never before had been suspected by surveyors walking over well-cleared ground. There then followed the

remarkable series of photographs of Stonehenge taken by Mr. Crawford, which made the alignment of the eastern avenue to Stonehenge perfectly visible. Anyone who had seen the photographs would realise that the camera in the air had provided an instrument which enabled them to see things which it was not possible to see whilst surveying on the surface of the ground. Mr. Bourne, to whom Col. Crosthwait had referred, spoke of the difficulty in a tropical country of making a survey on the ground because of the way in which the wood was hidden by the trees. That was perfectly true, but the reader of the paper had given an entirely new view of that old proverb, for the camera in the air had shown that the distant view was necessary to convert chaos into order. The physics of the camera in the air were extremely interesting. Their investigation arose from a series of problems that were first worked out in connection with the submarine. Many of the audience would remember how from aeroplanes it was possible to detect submerged submarines when they were not, for quite obvious and physical reasons, visible to the cruisers and scouts on the surface of the sea. The same thing had occurred with regard to the detection of ancient marks in connection with archæological works. A growing crop, especially a young crop, would show a slight difference of colour and a slight difference in its rate of growth over an old excavation on the chalky plains of Salisbury. That came out most perfectly from the air, and was seen very plainly in the photographs in a way that no one would detect in walking over the grassy downs of Salisbury Plain. The method Col. Crosthwait had described had been used largely in South Africa, the land which appeared to breed the spirit of enterprise. It was used during the war in Portuguese East Africa, and new routes were detected that never before were suspected to exist. It was used in German South-West Africa after the war in the mandated territory, when Professor Schwarz, of the Rhodes University College of Grahamstown, proposed that a survey should be undertaken of Ovamboland, in order that there might be a possibility of working out a scheme for the diversion of the River Kumene, which now ran into the Atlantic Ocean direct, and which could be easily diverted eastward into the old half-dry lake Etosha, thus saving from complete desiccation a large and valuable area between the basin of the Orange River and the present Kumene. Some of those present would remember that in 1922 Dr. Chalmers Mitchell, the very able and popular Secretary of the Zoo, in an aeroplane trip in Africa from north to south, detected the occurrence of volcanic rocks north of Khartoum which had not previously been detected by the ordinary surveyors. That was another fairly good illustration of the way in which an aeroplane survey could be utilised for reconnaissance work in geology. He also desired to say a word of appreciation of the memoir which Mr. Bourne had produced as the result of a specialised study of photographs taken in Northern Rhodesia. That was an example of a very detailed and special study of a series of photographs undertaken by a forestry expert, and Mr. Bourne had shown in his Memoir what an enormous amount of valuable information could be obtained from photographs taken so quickly. Those who had served in India would recognise Mr. Bourne as the son of Sir Alfred Bourne, the distinguished biologist, who was the Director of Public Instruction in Madras. The only other remark he desired to make was that he thought all present would agree thst the remarkable way in which the mere taking of photographs for amusement had passed into a serious and definitely systematised science was largely due to the enterprise of Mr. Alan Butler, the Chairman of the Aircraft Operating Company, the company which was responsible for the photographs of South Africa. It was due to Mr. Butler's enterprise and readiness to expend large sums of money that the method had

been brought to such a striking success. He desired, in conclusion, to express from the Chair his appreciation of the extraordinary results which the reader of the paper had brought to their attention.

Col. Sir Charles Close, K.B.E., C.B., Sc.D., F.R.S. (late Director General, Ordnance Survey), said that he was in almost entire agreement with the whole of the lecture. He agreed with what had been said that the development of Empire surveys ought to be taken up by those who were responsible, and he could not think of any method which was likely to give the desired results more readily and at less cost than a free adoption of the air survey method. He did not desire that remark to be taken as meaning, however, that the air method was of universal application. It was certainly not as useful, for instance, in hilly country. The method had not yet been thoroughly worked out. The Orange River Colony was mapped by Col. Winterbotham at a cost of £18,000, the time occupied being five or six years, and he did not think in that particular case better results would have been obtained if air photographs had been taken. He desired to emphasise that the new method must be used with reasonable discrimination. The Chairman had mentioned that Col. Elsdale in the early days took a great interest in air photographs for survey purposes. He (Sir Charles Close) served under Col. Elsdale for a year or two, and he had in his possession a photograph which he took about 1883 of part of Halifax, Nova Scotia. In that respect he desired to correct a remark the Chairman had made. Col. Elsdale's activities were entirely directed towards military purposes; he was not an archæologist at all. Col. Elsdale used to send up small balloons seven or eight feet in diameter with a camera attached to them and automatic release apparatus. The balloon went up 1,000 feet, released the automatic apparatus, and then came down wherever the wind chose to blow it. Very good results were obtained in that way. The case of Jamaica to which the Chairman had referred was even worse than had been stated. In 1905 the Colonial Survey Section was actually in Jamaica ready to make a map. The Government at home was ready to go shares in the cost of making that map, but the local Government would not do so, and as a result the Survey Section was sent to the Orange River Colony! The new method had shown its value, but it was not at present of universal application. There were still things in the old methods which were very valuable, and, as the reader of the paper had stated, it would not be possible, as a rule, to rule out the necessity for ground control.

Col. H. St. John Winterbotham, C.M.G., D.S.O. (Geographical Section, War Office), emphasised the immense importance of quick and fairly accurate reconnaissance surveys for roads and railways. Such a reconnaissance survey had recently been made of a particularly deep and difficult gorge in the heart of Africa, some forty miles long and very difficult to survey, at a cost of something like £2 a square mile, practically without any ground control worth mentioning, and at about one-tenth of the cost which would have been incurred by old ground methods. From the point of view of the alignment of railways and roads alone the new method had justified its use. This country now stood pre-eminent from the point of view of air survey, because it had been developed by the proper people. On the continent and elsewhere it had been pushed by the two extremes; on the one hand, by the scientific instrument maker, and on the other, by the airman. Here it had been developed by surveyor and airman in conclave. As a consequence the Continent had machines which weighed five tons from which doubtful results were obtained, or a mere mosaic. In England an instrument was used which

weighed only 7½ lbs. The 3-inch maps which were now being made by the War Office would set a new standard for the fidelity with which the ground was followed, and the amount of surface detail which the photograph enabled them to achieve. Col. Crosthwait had referred on several occasions to the trouble experienced in penetrating dense forests from a photographic point of view. It was the first axiom in any survey that the surveyor must see, and in many of the trials in densely afforested countries in the East the camera had been powerless to pierce the screen of tropical vegetation which hid the land forms underneath. As Sir Charles Close had said, there were occasions when the air survey method would not work, but on the other hand there were many occasions when it did.

MAJOR C. K. COCHRAN-PATRICK, D.S.O., M.C., said the Chairman had referred to British Guiana as one of the instances in which the Empire could have been developed in a better way. Personally, he spoke feelingly of British Guiana, because he was stranded in the middle of it one Christmas Day owing to damage caused to one of his flying boats, and as a result spent an uncomfortable week in the middle of the jungle. The instance of British Guiana only served to show how essential it was that not only should the Colonies be expected to carry out surveys, but that the Imperial Government should help in their cost. British Guiana had a very small population and a small income, and could not be expected to incur the fairly heavy expenditure which was necessary to complete a really comprehensive development survey of the entire Colony. It was necessary for the Government at home to help the Colonies to carry out essential surveys. The Chairman had mentioned the work done by Col. Beazeley in Bagdad and Mesopotamia, and it was very interesting to note how, in the survey which was at present being made, the system of canals showed up on the photographs. There were most amazing systems of ancient canals which must at some time have irrigated extensive areas of desert which now were useless. It merely served to emphasise the fact that enormous areas existed in that country which could quite easily be developed, as they had in the past produced useful crops. An unfortunate feeling seemed to exist that the air surveyor was in direct opposition to the ground surveyor, but that was not at all the case. Unfortunately, air survey began by airmen taking photographs and trying to piece them together in mosaics, but certainly in this country the airmen very soon realised that that plan was quite impossible, and they were now trying very hard to teach themselves to be ground surveyors. They were very glad when a ground surveyor came along and tried to look at things from the point of view of the airman and of the photographer, because it was only by a very close combination of the three essential elements, the flying side, the photographic side, and the drawing office side, that really efficient and economic results could be obtained.

In addition to the special instruments which it had been necessary to construct to meet the requirements of air survey, they had found it essential to design a special aeroplane.

This machine, which was at present under construction, would be capable of climbing to more than 20,000 feet, at which height it would still have a very high speed. It would be fitted with two engines but would be able to fly comfortably with either engine stopped without running the remaining engine at more than ¾ throttle. This should give it almost complete immunity from forced landings.

The pilot would be seated in the extreme nose, so that he might have the maximum possible view for photography, while the photographer and his cameras would be comfortably placed in a roomy cabin with direct communication with the pilot.

In addition the machine would be capable of cruising for 7 hours so as to be capable of working at a long distance from the main base.

BRIG.-GEN. E. M. JACK, C.B., C.M.G., D.S.O. (Director-General, Ordnance Survey) supported very strongly the remarks the lecturer had made in regard to the application of the new method to the development of the Colonies and Protectorates. The application of air photography to survey had given the surveyor a new and extraordinarily valuable instrument. That application of photography was probably the greatest single development that had taken place in the science of survey since it was practised, and those who were responsible for the administration of undeveloped areas ought to take advantage of the wonderful new instrument which had been placed in their hands. The Ordnance Survey had its own peculiar problems. They were not dealing with the development of a new country, but with the maps of a well-mapped and highly-developed country. Those maps were very intricate, and a great deal of ground work was necessary for the collection of names, the investigation of boundaries and so on, and it was very largely open to question to what extent, if at all, photography could be used in Ordnance survey work, which was largely the revision of those maps. They had been experimenting for two or three years and were continuing the experiments, but he was not yet in a position to say to what extent air photography would be useful as a permanent method, although he thought there was no doubt a great deal of field work might be saved by means of its use. Major Cochran-Patrick had referred to the supposed feeling of opposition which existed on the part of the ground surveyor to the air surveyor. As a ground surveyor he could assure Major Cochran-Patrick that no feeling of that kind existed, certainly at the present time. The only opposition ground surveyors ever felt was to those who imagined in the early days of air survey that it was going to abolish the old methods. That, of course, was simply due to ignorance. As Major Cochran-Patrick said, air survey was an addition to the old methods, and it was necessary for all concerned to work together, as he was sure they were only too anxious and willing to do.

MR. R. BOURNE (Imperial Forestry Institute, Oxford), emphasised the point made by Major Cochran-Patrick, that it was necessary in the development of aerial survey to have a maximum measure of co-operation. Personally he approached the question not as a surveyor, but as a forester. He had been interested more in the aspect of the interpretation of air surveys. He had followed with great interest the work of the Canadian Forest Service, and the point was worth mentioning that there was actually an air section of the Canadian Forest Service comprising its own staff and survey personnel. This section of the Canadian Forest Service had not only to deal with the question of fire protection work, which was proving of enormous value, but it was also employed both by Governments and by private pulp and paper firms for taking stock of the merchantable properties of the forest. It was perfectly true that, where there was a dense forest canopy, an air photograph would not penetrate, but at the same time it indicated very clearly the distribution of the different vegetation types. The view from the air gave an idea of the forest distribution and indicated how the forest could be sampled. If a perspective view of the problem could thus be obtained a relatively true idea was presented of what the forest contained. Having obtained a general idea of how to sample an area, the next step was to take the vertical and oblique photographs on to the ground and to ascertain what they showed. A forest officer could not be expected to be a specialist in all subjects, and he, therefore, suggested

hat, with a view to the interpretation of the aerial photographs, when the ground-vork was being done, specialists representing different branches should bring their xperience to bear on the problem in the field, so that they would come to understand ach other's point of view. If selected members of the field parties would then e-fly over the same area, they could, with the maps prepared by the surveyor, ketch with very considerable accuracy the distribution of the different forest ypes, obtain a clear idea of the geological formation, and often get a clear idea s to the distribution of different soils.

AIR VICE-MARSHALL SIR SEFTON BRANCKER, K.C.B. (Director of Civil Aviation, ir Ministry), in proposing that a hearty vote of thanks be accorded to Col. Cros-hwait for his exceedingly interesting paper, mentioned that while the air operating assenger companies received a subsidy, the Air Survey so far had not cost the ountry a penny; and the best proof that the undertaking was a business proposition as the presence of the reader of the paper on the Board of the leading company 1 this country. Personally, he thought those concerned should be proud of the ict that the Air Survey had never been on the dole, but that those concerned had lways paid themselves for the service rendered. The trouble about air survey as that it did too much work in too short a time, and the expense was often mparatively large in view of the overhead charges. If several Colonies could e induced to have air surveys made at the same time, so that the aircraft could e fully employed, the overhead charges could be distributed, and, as a result, e price considerably reduced. Col. Jack had referred to the question of the ringing up to date of the Ordnance Survey of this country. In that respect e Treasury limited the Ordnance Survey to so many square miles per year, which ne aeroplane could do within three weeks. He was perfectly certain it would be very good thing if the Air Survey could correct the Ordnance Survey every year om top to bottom, but the Treasury would not agree to that. One of the most ficient Air Surveys that had been carried out was that of Rhodesia, where aviation orked hand in hand with the ground organisation. There were skilled surveyors 1 the ground under the command of the Air Survey, and he believed that was hat would happen in the future. He was not at all sure, either, that that pre-ominance of the air was not what would happen in regard to war in the future. e agreed with the Chairman that Air Survey would be a very big factor in the velopment of the Empire. Every Colony and Overseas Dominion now realised iat, if they could afford to make an Air Survey, it should certainly be carried it. He moved that a most hearty vote of thanks be accorded to Col. Crosthwait, t only for his paper, but for the pioneer work he was doing in a most important evelopment.

The resolution of thanks was carried unanimously, and Col. Crosthwait having iefly acknowledged it, the meeting terminated.

COLONEL C. H. D. RYDER, C.B., C.I.E., D.S.O., late Surveyor General of India and iairman, Air Survey Company, had to leave before the discussion, and sends the llowing remarks :—

" It is somewhat saddening to realise that even now so much of Colonel Crosth-iit's interesting lecture has had to be devoted to stressing the necessity of surveys id maps. It seems so obvious and yet it apparently is not so to many Colonial ithorities.

I have seen it mentioned, I think, by Colonel Macleod, that it is a curious thing at while official surveyors have been dinning into the ears of Colonial Governments

the necessity of maps, the latter pay more attention to the proposals of commercial companies ; if this is correct, I think it shows the advantage of having one method of surveying, air survey, carried out by companies and not by a Government department. The two names which should be mentioned in this connection are those of Mr. Alan Butler and Mr. Ronald Kemp, who have financed the two British companies through their early trials and experimental work.

I would only like to add how much I have enjoyed my old friend Colonel Crosthwait's paper, and how helpful the ventilation of this subject should be to all concerned.

NOTES ON BOOKS.

IMPURITIES IN METALS : THEIR INFLUENCE ON STRUCTURE AND PROPERTIES. By Colin J. Smithells, M.C., D.Sc. London : Chapman & Hall, Ltd. 18s. net.

Although the main relationships between composition and micro-structure in alloys have now for some time been established by metallographic investigation, it is only recently that due attention has been paid to what Dr. Smithells calls " minor constituents." By this term he simply means substances present in very small proportion. It makes, of course, no difference, from the metallographic point of view, whether such substances are present as accidental impurities or whether they have been added deliberately ; and Dr. Smithells explains that he would have used the term " minor constituents " in his title if there had been no risk of misunderstanding.

The book is intended for those who are already familiar with metallographic work, but it commences with a brief and exceedingly lucid description of crystalline and metallic structure in general, and of the methods by which this structure is determined. Since the application of X-rays to the problem is of somewhat recent date, this subject is treated with greater fulness ; and the chapter in question, while avoiding experimental and other detail, gives an unusually well-balanced and informative account of the principles on which the method is based, and of the broad conclusions which have resulted from it.

Microscopic and thermal investigations, though they still remain the principal means of attack, are more rapidly dismissed, presumably as being more familiar to the metallurgist ; and the remainder of the book is devoted to a consideration of the effects, often disproportionately great, of the presence of foreign substances to the extent of about 1 per cent. or less.

From the industrial point of view it is the effect on the mechanical properties of the metal that is as a general rule the most important result ; but this effect is always in close relation with a change in the visible microscopic structure, and is usually easily understandable when that structure is properly examined. Though it is not always practicable to make a very hard and fast distinction, it is possible roughly to classify the foreign substances as metals, non-metallic solids and gases ; and in each of these classes a full account of the resulting structural alterations is given.

Apart from purely mechanical properties, there are, of course, others, such as electrical conductivity, resistance to corrosion, etc., which, in certain cases, assume considerable economic importance, and these are fully discussed in the two last chapters. Though lacking a bibliography, which indeed, would have to attain almost impossible dimensions in order to be of real value, the book is well provided with references, most of which are of very recent date.

EXHIBITIONS OF APPLIED ART.

Claridge Gallery. Exhibition of Decorative Art.—This is a small but comprehensive exhibition in which foreign work is displayed as well as British; and much that is pleasing and desirable meets the eye at a first glance. The influence of Fitzroy Street is shown to be disseminated throughout the various provinces of decorative art; Mr. Duncan Grant and Mrs. Bell themselves being represented by interesting painted screens. Their disciple, Mr. Douglas Davidson, has more than a little talent, and it would be doing him less than justice to say he was no more than "school of Grant"—though this would be a tribute to any young man's good sense. Mr. Davidson's embroidered table top in shades of grey is an excellent piece of work. His rugs are good also; on the other hand his screen, though strong, and in no way gimmicky, has a touch of the uncouth; the room where it would be in harmony would itself be out of tune for repose.

Mr. Rex Whistler, of Millbank refreshment-room fame, who rightly enjoys a discreetly solid reputation, is represented by what is described as a corridor panel. The style is that of the Millbank wall-paintings: ghostly figures flit charmingly in a picturesque landscape of dull green tones, the whole being seen through a classical portico. As a change from the bright and warring colours of some moderns, Mr Whistler's conceptions are welcome; the suggestion of respect paid to tradition, though gaily, is also a congenial touch. But is not this decorator like someone who, having found a perfect recipe for fricassee of chicken, is reluctant to serve up anything else? It is hard to see on what lines this style is going to be developed; it is at present not an altogether satisfactory end in itself.

The trees of glass and precious stones convey a strong feeling of luxurious refinement; their æsthetic justification is not apparent, though they stir the senses. The portrait painted on glass by Mr. Messel is crude. Mr. Adrian Allinson has at least one curious and pleasing pot, of which one example is blue and one white (No 55); the strange ribs being accountable for the vitality of the piece.

The standard of design shown by the artists responsible for the printed stuffs is high throughout; indeed, this little exhibition is heartening; there seems no department of decorative art in which healthy and even original influences are not at work. These influences could and should be much more widely felt. In Duncan Grant we have a painter and decorative artist whose name has in a most significant way already found its way into foreign text-books. The boldness and sureness of his design is not merely original; in certain respects modernity is what he decides it should be. His genius, all craftsmen should observe, lies not in simply adding a little rouge and lipstick to the face of the utilitarian modern world, but in finding congruous methods of transforming something useful and ugly into something useful and beautiful.

Arlington Gallery. Exhibition of Modern Furniture. Russell Workshops, Broadway, Worcs.—The Russell Workshops are situated in the village of Broadway, the famous old-fashioned spot of which one interesting feature is the craft centre itself: blocks of cottages built on a logical and attractive plan from the designs of Leslie Mansfield. In this ideal environment is produced sound furniture, which, though not old-fashioned, is not too self-consciously modern. We see no particular straining after a modern style at the present exhibition; the most up-to-date items are the very fine carpets of the Austrian designer, Resch, who works in co-operation with Russell's.

The modernness of the furniture consists in its simplicity, usefulness, and reliance

on the intrinsic æsthetic qualities of the woods employed. There is a handsome bookcase, No. 23, perfect, but for the pattern cut on the glass, an unnecessary disturbance of its serenity. The price is the large one of fifty guineas; however, the air of slenderness and strength of the rosewood case with its inlay of ebony and rustless steel door-frames is very captivating. On the opposite side of the room stands a fine grandfather clock, also in rosewood, the general aspect of which is quite old-fashioned. Good work like this makes nonsense of "periods"; the clock would not be out of place in many a decorative scheme whether of predominantly "period" or modern character.

Worthy of note are the yew-tree chairs which form part of a dining room set mainly in English oak. The lacquer bedroom set is not unattractive, though the decorations are ineffective. I understand this is the first time Messrs. Russell have experimented in this medium.

On view also are some of Mr. Paul Nash's charming printed stuffs. Messrs. Russell are animated by a liberal spirit; not only do they keep in touch with artists like Mr. Nash and Herr Resch, but, as we read in Mr. Thorp's introduction to the show: "the men at the bench, and, *a fortiori*, the foremen, (i.e. at Broadway) are taken into consultation, and not infrequently adaptations of form . . . . are devised in the shops."

Mr Thorp touches on the question of the place of machinery in the workshop. Reasonable minds do not condemn machines, but the too wide use commonly made of them. There is a point up to which machines support and help on the development of the human individuality. Beyond that point they are obstacles to such development. It is the very proper idea of Messrs. Russell that by the discreet use of machines the workman should be "spared some hard donkey work and set free for the more delicate and intricate problems of his job."

Russell workshops are a growing concern. Where possible they join to themselves craftsmen performing services auxiliary to their primary needs. Broadway has thus become an important centre for more crafts than that of the cabinet maker.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, JANUARY 1..Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses, Notes and Noises." (Lecture III).

WEDNESDAY, JANUARY 2..Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Wireless Section Meeting. Messrs. P. P. Eckersley and H. L. Kirke, "The Design of Transmitting Aerials for Broadcasting Stations."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr. G. Wilkinson, "Economic Application of Electricity to Low Temperature Heating Purposes."

THURSDAY, JANUARY 3..Linnean Society, Burlington House, W. 5 p.m.

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—How Sounds are Analysed." (Lecture IV).

FRIDAY, JANUARY 4..Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Major A. W. Farrer, "The Engineer Salesman Abroad."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 3.30 p.m. Dr. Hugh R. Mill, "Captain Cook's quest of the Southern Continent."

At Engineering and Scientific Club, Wolverhampton. 7.30 p.m. Mr. J. P. Fuery, "Patents for Inventions and their Relation to Trade."

Transport, Institute of, at Leeds. 7 p.m. Paper by Mr. Percy Beetham.

SATURDAY, JANUARY 5..Education Fellowship, New, at the Central Hall (Library), Westminster, S.W. 5.30 p.m. Sir Michael Sadler, "Examinations."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. A. Wood, "Sound Waves and their Uses—The Ear and What it Does." (Lecture V).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

NEXT WEEK.

THURSDAY, JANUARY 10TH, at 3 p.m. (Dr. Mann Juvenile Lecture). CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, "Ships and Lighthouses" (illustrated by lantern slides). Tea will be served in the Library after the Lecture

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

WEDNESDAY, NOVEMBER 28TH, 1928.

THE RIGHT HON. THOMAS WILES, P.C., in the Chair.

THE CHAIRMAN, in introducing the Lecturer, said he was a member of the head-quarters staff of the Port of London Authority. An American would probably describe him as a "live wire." But what a field he had to cover in his subject of that evening! The river Thames, with the Port of London, was once described as seventy miles of "liquid history," from the little Nore lightship bobbing up and down in the North Sea right away to the respectable suburban district which surrounded Teddington Lock. The speaker had often thought that Londoners were very ignorant of their docks. Probably not 10 per cent. of the seven millions of people who inhabited Greater London had ever seen the Docks, and he doubted whether very many more had ever seen the river Thames—anyhow, if they had seen it, it was only as a grey stretch of water between Blackfriars and Westminster, or, perhaps, a golden stream between Maidenhead and Windsor. But he thought he could say without contradiction that if it had not been for the river Thames there would have been no London to-day. It was a unique river, because it had this wonderful tide, flowing backwards and forwards, carrying goods freely from

one end to the other, night and day, guided by no motor or steam power, but by the lightermen, who were most wonderful craftsmen, steering these vessels on the tidal way, up and down the river, alike in summer and winter, in fog and frost and any kind of weather. It was the river which had created the miles upon miles of factories and mills and wharves along its banks. In the old days the Egyptians used to worship the Nile, and the Romans Father Tiber. Londoners should make obeisance to Father Thames who had made their city the greatest city in the world.

How had the Thames been managed? He ventured to say, even before that audience, that the Thames had been mismanaged and muddled for centuries. It had been managed by conservators, docks directors, borough and county councillors, Trinity Brothers, in fact, so many overlapping authorities that it was almost impossible to manage the Port and the river Thames at all. About 25 years ago a Royal Commission was appointed, and reported in favour of a body which should have power to deal with the whole of the Thames, from Teddington to the Nore. The speaker well remembered the Bill in Parliament, because he had happened to make his maiden speech, very humbly and nervously, on that very Bill when it was brought up in 1907.

The Port of London Authority, which was created in 1909, consisted of 28 members, eighteen of whom were elected by the payers of dues, and ten appointed by the Board of Trade and certain public bodies. The members were elected for three years so that they should not get into an antiquated state like that of some other bodies. It was also a non-political Authority. There were no politics in the Port of London. He had never served on a public body which got on with its work as quickly, and quietly, and well as this Authority did. Since it had been established great marks had been made on the Port and on the river. The river had never been well dredged, and very large ships now came into the docks. The docks had been improved and modernized and brought up-to-date. The King George Dock—he believed the finest dock in the world—was one of the sights of London, and one which the Government always sent distinguished visitors to see. At present the Authority was making a landing-stage at Tilbury, so that the ocean-going steamer would come up to the landing-stage, and the train from St. Pancras would take passengers right along-side. Everything was being done to bring London up to the requirements of modern shipping. He ventured to say that to-day the modern machinery, the good equipment, and the efficient service made London an unrivalled port in the world, and there was no doubt that the Authority was carrying out the motto on its flag: "*Floreat imperii portus.*"

The following paper was then read:—

THE PORT OF LONDON.

By J. H. ESTILL, O.B.E., Commercial Manager, Port of London Authority.

It is often said that "comparisons are odious," and this, of course, is probably true of many things, but I hope I may be forgiven in this instance, as it is only by comparison that one is able to appreciate the relative commercial position of the various ports.

Whether the basis of comparison be the volume of tonnage of shipping entering its river, the weight and value of the commodities imported and exported, or the extent of its international markets, London has long been the greatest port in this country and probably in the world.

London was the principal port of Britain before it became the capital, and its greatness as a city has increased coincidentally with its commerce. Many circumstances have combined to effect this progress, but the chief are the geographical and physical advantages enjoyed by the port. London is about sixty miles from the sea, which makes it not only a safe depot for valuable merchandise, but gives it an advantage as a market and distributing centre for the United Kingdom. The mouth of the Thames faces the mouths of the Rhine and the Scheldt; the Elbe is not far distant. Continental trade between London and ports on these rivers is therefore easy.

The physical advantage of the port of London is its broad and deep river, enabling vessels of the largest class to enter its docks with facility.

The earliest reference to London in history is as a *port*. The Roman historian Tacitus, writing in A.D. 61, states that "Londinium, though undistinguished by the name of a colony, was much frequented by a number of merchants and trading vessels."

During the Roman occupation London became a depôt for luxuries required by the Roman settlers and for the export of corn to the legions on the Rhine. The London Stone, which is now enclosed in a stone case and built in the outer wall of St. Swithin's Church, Cannon Street, was in Roman times the central millarium, or milestone, similar to that in the Forum at Rome, from which the British highroads radiated and from which distances were reckoned.

In Saxon times trade developed with the lands whence the Saxons came, and the Venerable Bede testifies to the international character the trade of London had assumed in the seventh century when he states that "London is the metropolis of the East Saxons, situated on the banks of the aforesaid river, and is the mart of many nations resorting to it by sea and land."

It was not until Elizabethan times, however, that London forged ahead of Antwerp, her greatest competitor.

You will remember that it was in Queen Elizabeth's reign particularly that England's Merchant Adventurers penetrated rich and fertile lands in various parts of the world and began that conquest of trade which laid the foundation of our commercial greatness. Tropical and other produce carried by British ships was poured into London, which soon became the greatest market of Europe.

England's overseas trade continued to develop during the next 150 to 200 years and it continued to be centred very largely in London, where the great Trading Companies, such as the East India, the Levant and the Hudson's Bay had their headquarters.

At the close of the 18th century vessels from overseas sailed in convoys, owing to the Napoleonic Wars, and, as they sailed practically at the same time after the harvesting of some particular product and when winds were favourable, the arrival of all these vessels at one time, plus the colliers and

other coasting vessels, caused great congestion on the river. (I may remind you that before the advent of railways all coal was carried by ship). Owing to the wharves and legal quays being blocked with merchandise it was impossible for ships to discharge their cargoes for months together. Thieves did a roaring trade; it is computed that there were no less than 11,000 of these river thieves about the period mentioned. Sir Joseph Broodbank, in his admirable book on the history of the Port of London, points out that so many and various were these gangs that they were classified. There were "River Pirates," "Night Plunderers," "Scuffle Hunters," "Light Horsemen," "Heavy Horsemen," and "Mud Larks." Several estimates were made as to the amount of the losses, but no satisfactory data existed for making the calculation. The estimates placed the aggregate losses from plunder to merchant and the public revenue at from £250,000 to £800,000 per annum. Whatever the figure, the losses suffered by the merchants and the Crown in revenue were so serious that the idea was conceived of constructing a protected water area in which vessels could lie and discharge their cargo in safety. Such were the conditions which existed until about the year 1800.

The first enclosed wet dock in London was constructed about the year 1700 (actually begun about 1696) and was known as the Howland Great Wet Dock It was what we should now consider a very primitive affair. It had a water area of ten acres, a single pair of gates only, and no warehouses or storage accommodation. It was not until the end of the 18th or the dawn of the 19th century that, through sheer necessity, the building of docks in London was undertaken on a large scale.

The first dock of importance was the West India Dock--promoted by the West India Merchants and opened in 1802 by Wm. Pitt, then Prime Minister, and to-day this is the chief dock for the storage of sugar and rum. Other groups of merchants having interests in the East and elsewhere soon had their own particular docks (London Dock for wine, brandy, tobacco; the East India Dock for general merchandise from India, China, etc.).

For about 100 years after the building of the West India Dock the business of the port continued to increase but owing to financial difficulties, principally brought about by severe competition between the various dock companies and the public wharfingers, the dock companies were unable to carry out the extensions and improvements which the ever-increasing trade of the port demanded.

As a result of the outcry by the traders and the public the Government appointed a Royal Commission to inquire into the whole question. The final result was the creation of the Port of London Authority in 1909.

There were thus transferred to the Authority by Act of Parliament the docks of the London and India, Surrey Commercial, and Millwall Companies, and the control of the tidal portion of the river Thames, a distance of 69 miles, formerly under the administration of the Thames Conservancy. The river above

Teddington is still controlled by that body. The Act also transferred to the Authority the powers of the Watermen's Company, so far as it related to the registration of craft and of lightermen and watermen. The purchase price of all these undertakings was fixed by the Act at nearly £23,000,000.

The Port of London Authority to-day consists of 29 members, 18 of whom are elected by payers of dues and charges and 10 are appointed by public and Government departments, such as the Ministry of Transport, Corporation of London, London County Council, etc. The present Chairman was elected by the other 28 members from outside their number.

In short, the Port is controlled by those whose interests are closely allied to it, and, as our charges are occasionally criticised, it will be some satisfaction to those critics to know that those who are responsible for the rates and charges have to pay the same themselves. It will, therefore, be appreciated that the interests of the members of the Authority and their critics are identical.

The water area of the docks alone is 720 acres. There are 36½ miles of quays, whilst the entire estate is 3,234 acres.

About 25 million tons of merchandise enter the Port of London yearly, about 14 million tons being from overseas.

The important position which the Port of London occupies in relation to overseas trade is indicated by the fact that in 1926 (the latest year for which complete Board of Trade figures are available), the value of London's imports and exports, excluding coastwise, amounted to nearly £702,000,000, exceeding those of Liverpool, the next most important port, by more than £193,000,000, and being nearly twice the values of the combined imports and exports of Hull, Manchester, Southampton and Glasgow. Put in another way, one-third of the total import and export trade of the United Kingdom is dealt with through the port of London. Within the last few days the Board of Trade have issued preliminary figures which show that in 1927 London's import and export trade, excluding coastwise, amounted to over £706,000,000, exceeding Liverpool by £225,000,000.

The enormous growth of London's trade can be judged from the fact that in 1700 the value of the imports and exports was £10,264,000. £10,000,000 worth of merchandise in those days was considered a high figure, and it undoubtedly was so, as such commodities as sugar, rum, wines, spirits and other valuable articles were the principal imports.

Within the last few years there has been a decided tendency for additional industries, such as motor car manufacturing, engineering and paper making, to be established in or near to London, and for important businesses to be centralised here. This is doubtless due to the development of electricity and to the shipping, trading and other facilities in which London is pre-eminent.

As a further indication of London's commercial greatness, one has only to turn to the financial transactions of the city. In 1927, out of a total sum of

£41,550,541,000, which passed through the Bankers' Clearing House, £38,577,714,000 were dealt with by London.

The net register tonnage of vessels entering and leaving the port has increased from 650,000 in 1700 to the huge figure of over 52½ million tons in 1927, which is over 14 million tons more than in the first year the Authority took office and constitutes a record in the history of the port.

I submit that these shipping and trade figures prove that the Port Authority's bold policy of extensions and improvements, involving an expenditure of £15,000,000, has been amply justified. The outlay of additional capital, however, necessitates increased business and it rests with the Traders of London to help the Port Authority by using the facilities provided. By so doing they must inevitably benefit themselves, since the larger the volume of tonnage handled by the Authority, the wider the area over which the overhead charges can be spread.

A comparison of the shipping figures for the out-ports shows that in 1913 London's figures exceeded those of Liverpool, the next leading port, by 9,000,000, and in 1927 by over 20,500,000 net register tons.

Over 60% of the shipping entering the port discharges in the docks, the remainder at wharves, at manufacturers' premises or at moorings in the river. A large part of the cargo, not intended for immediate consumption, goes into the Authority's warehouses on the docks and quays. This warehousing business is of great importance, comprising, as it does, every class of merchandise entering the port. The principal are grain, timber, wines and spirits, wool, frozen meat, sugar, tea and tobacco.

About 2½ million tons of imported goods yearly are passed over the Authority's quays, while the normal stock of goods stored with the Authority is about 600,000 tons, a striking figure when it is remembered that the modern tendency is for goods to go directly into consumption, and that the need of holding large stocks is far less pronounced than it used to be. The stocks held by the Authority in 1921 however totalled over 1,000,000 tons.

It is often supposed by strangers who visit the docks that the produce stored in the warehouses is the property of the Authority. This is not the case. The Authority import absolutely nothing. They are, as a body, neither growers, producers nor importers of produce. They are custodians only.

In addition to the ordinary labourage connected with the handling of goods ex ship the Authority have a staff of experts who perform such operations as the owners of the goods may direct. They house the produce discharged from the vessels; report upon its weight, quality and condition to the merchants interested, sort it to quality and to marks; open packages containing such goods as are sold by inspection of the whole package, and furnish samples which represent the exact condition of the produce. These samples are sent for exhibition to the London sale rooms where they are inspected by intending buyers.

The Authority also carry on a large business in the conveyance and shipment of export goods, the normal quantity passed over the quays annually being about 700,000 tons.

However, it is in connection with some of the interesting businesses warehoused and dealt with by the Authority that I wish particularly to speak this evening.

We will commence our hasty tour of inspection at the Authority's Uptown Warehouses.

CITY WAREHOUSES.

One of the Port Authority's city warehouses is known as Commercial Road Warehouse. It was specially designed for the accommodation of the traffic to and from the Tilbury Dock, being directly connected by rail with that dock. The total floor area of the warehouse is approximately eight acres.

In addition to being used for the accommodation of traffic landed at the Tilbury Dock, Commercial Road Warehouse is used for the storage of Indian, Ceylon and China teas.

Cutler Street warehouse is another of the Authority's City premises. It covers an area of five acres, holds 20,000 tons of goods, and has an average stock of merchandise worth about £5,000,000. Thousands of tons of tea are stored there besides carpets from Turkey, Persia and China, and cotton carpets from Bengal and Northern India. Porcelain from China and Japan is also stored there.

In this warehouse are to be found large quantities of Oriental curios, including gods from the four corners of the earth; in fact, more gods are stored there than it is generally supposed are worshipped! In addition, there are carved ivory figures, bronzes, lacquer cabinets, silk and satin screens beautifully embroidered, vases and bowls of beaten brass, Egyptian and Persian coffee pots and holders, Japanese pictures, and ancient manuscripts from Persia and Mexico; also raw and waste silk and silk and cotton piece goods from China, Japan and Bengal, the silk and cotton piece goods alone being equal to 5¼ million yards, valued at over £650,000.

The warehouse is also the centre of the ostrich feather trade. About £3,000,000 worth of these feathers, principally used for trimming ladies' hats, formerly passed through this warehouse every year and, although we still have large stocks on hand, this great industry, which furnished employment for a great number of people and, incidentally, brought revenue to the coffers of the Authority in warehousing charges, etc., is now practically dead.

Ostrich farming in South Africa was also a flourishing business, but as there is now little demand for the feathers, the birds are being slaughtered wholesale. All this has been brought about by the change in the fashion of ladies' hats, due to the fact that the ladies now shingle and permanently wave their hair. In fact, a whole industry overwhelmed by a permanent wave!

While the ostrich feather industry has declined, the Authority are warehousing considerably more silk and silk stockings. Thus, while fashion has robbed us of the ostrich feathers which formerly adorned ladies' hats, it has given us a great display of silk stockings! This display is pardonable even when the stockings leave our warehouse. When ostrich feathers were worn the full value was displayed. Therefore, one cannot blame a young lady who pays, say, 10s. for a pair of silk stockings, wanting to show at least 8s. 6d. worth!

There are nearly three acres of floor space available for showing and storing carpets at Cutler Street, the present stock being about 1,350 tons, representing 800,000 square yards of an approximate value of £2,000,000.

It is at this warehouse, also, one may see all the great drug staples of the world, such as aloes wrapped up in monkey skins (no doubt there is a scarcity of paper and other suitable wrapping in Africa, where aloes principally come from, while monkeys are plentiful), gamboge, ipecacuanha, sarsaparilla, Turkey rhubarb and gum benjamin.

The extensive warehouses at Cutler Street and Commercial Road are also used by the Port Authority for the storage of tea, of which about 50,000 tons (including that dealt with by tenants at St. Katharine Dock), are housed and delivered annually.

In 1927 London received 496,000,000, lbs. of tea, more than 90% of the total importation for the United Kingdom.

To-day the stock of tea in the port is about 186 million lbs., valued, with Customs duty, at over £16,000,000.

This stock is equal to nearly 5¼ months' supply for the United Kingdom at the present rate of consumption, viz., 9 lbs. per head per annum. The rate of consumption in the U.S.A. is less than 1 lb. per head per annum, and on the Continent less than ½ lb. Thus there would appear to be a great future for tea, especially in the U.S.A., where legislation prohibits the importation or manufacture of alcoholic beverages.

ST. KATHARINE DOCK.

The St. Katharine Dock has a water area of only 10 acres and is the smallest of the docks in London, being used by the smaller class of vessels, i.e., vessels up to 1,000 tons gross register. It was commenced in 1827 and publicly opened in 1828.

The dock, although small, serves a useful purpose, as it is surrounded by fine ranges of warehouses which contain tea, indigo, hops, dried fruit, canned goods, wool, shells, etc.

Four large and well-lighted rooms are devoted to the use of shell importers. Here large supplies of valuable shells, brought into the Thames from all parts of the world, are opened by the Authority's officers, weighed, sorted and lotted for the public sales, which are held six times in every year.

Tortoiseshell is also warehoused at this dock At the sales of tortoiseshell as many as five hundred lots are sometimes shown, arranged in three tiers round the windows.

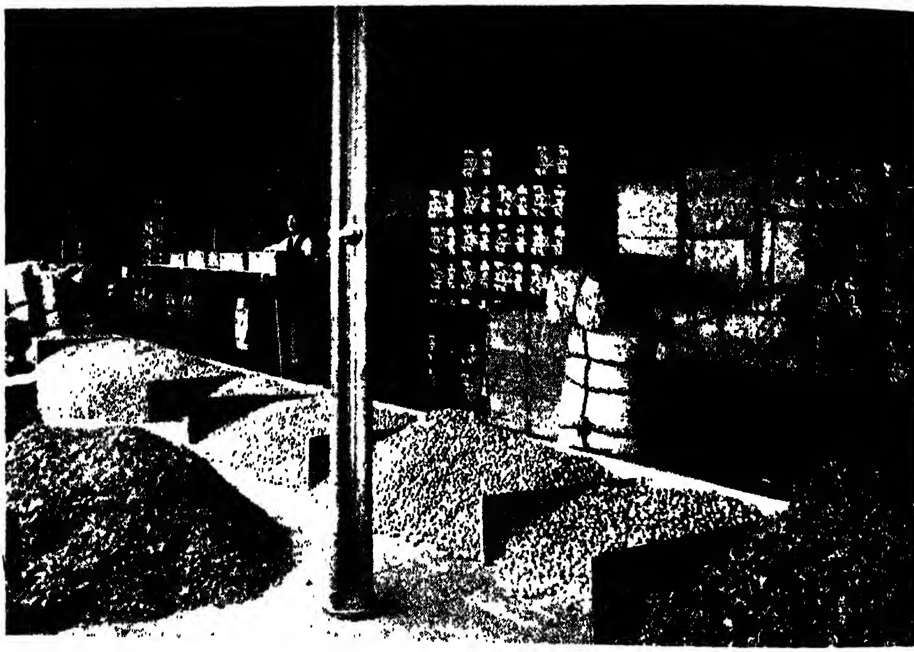
LONDON DOCK.

The London Dock, which was opened in 1805, is adjacent to the St. Katharine Dock and has a water area of 35 acres. This dock also accommodates the smaller class of vessels, but the warehouses, which are very substantially built, house some of the most valuable articles entering the port of London. There is accommodation in the warehouses for about 220,000 tons of goods. Special premises are set apart for warehousing, working and showing wool, tallow, wine, brandy, sugar, rubber, gutta percha, balata, dried and green fruits, ivory, spices, bark, gums, metals, drugs, dates, pepper, rice, coffee, cocoa, isinglass, iodine, quicksilver and many other valuable goods.

A warehouse is provided at London Dock for the storage of ivory, the bulk of which comes from Africa and from India, Ceylon and other Asiatic countries. A small quantity, brittle in quality, comes from Siberia, under the name of fossil ivory, being tusks of extinct mammoths which have long been buried in the frozen soil of that region. The ivory of Africa is shipped from almost every port in that Continent, and is superior in density and whiteness to any other description. It may here be said that many, perhaps most, of the tusks of elephants shown are not from recently killed beasts, but are the old treasures of African chiefs reluctantly surrendered, and stored, may be for centuries, in remote African villages.

When received at the docks the ivory is weighed by the Authority's officers, examined, classified, and laid out for the merchants' inspection. Special attention has to be directed to the detection of stones and metal, which are sometimes inserted by the natives in the hollow at the root of the tusk in order to increase the weight. The tusks are sometimes 9 feet in length, weighing 140 to 150 lbs. each, and the value is now about fifteen shillings per lb. The annual importation of ivory into London is about 200 tons, representing the ivory of about 2,500 elephants. Accommodation is also available for cinnamon, nutmegs, mace, pepper and other spices. Every package of cinnamon has to be opened by our men and repacked in order to discover whether the material inside is of equal quality to that which is visible to the naked eye. Sometimes they discover pieces of wood inside the bales. Cinnamon is the inner bark of a tree and is folded into quills. It is used for cookery and in chocolate, and is a great specific for influenza. Some years ago, during an outbreak of influenza, a deputation of medical men visited the docks to inquire whether any of the men working on the cinnamon floor suffered from influenza, and it was discovered that none of them had it, or had ever had it.

One of the floors of the spice warehouse at the London Dock is used for sorting nutmegs, which are very liable to the attack of a beetle and are often coated with lime before shipment as a protection against this insect, which bores holes and spoils the nutmegs. Before the nutmegs are sold our men have to look at every one and separate the holey ones from the sound. The holey ones are ground up and sold as mixed spice and the very lowest quality used for giving a flavour to cattle food. Nutmegs come from Singapore, Penang, Madagascar and the West Indies, and are the kernels of a fruit of which mace constitutes the husk.



Sorting Nutmegs—London Dock.

Another commodity warehoused at London Dock is rubber. In 1927, 371,000 tons of rubber were exported from the plantations in the Malay Straits and other producing countries; of this London received one-third.

The greatest consumer of rubber is the U.S.A., which obtains supplies not only from London but by direct shipment from the producing countries. They take 75% of the world's production, but this will be appreciated when it is remembered that out of a world total of 30,000,000 motor cars the United States of America owns 25,000,000, or one car to every five persons, compared with one car to every thirty-six persons in the United Kingdom. There are three floors at London Dock, each 250 feet in length, reserved for the "working" of rubber.

Colonial Wool on show, London Dock.

The total number of sheep in the world is estimated at 604 millions, producing about 9 million bales, or over 1¼ million tons of wool yearly. About 45% is produced in the British Empire. The United Kingdom takes about one-fourth for manufacturing purposes, and of this nearly one-half comes to London.

Put in another way, London deals with over 55 million sheep fleeces yearly and a large proportion is warehoused at London Dock, being in point of both tonnage and value one of the most important articles dealt with there.

The Port Authority make a special study of the handling of wool and devote ten acres of well-lighted top floors for showing purposes. 40,000 bales can be shown at one time. A further 20,000 bales can be shown at privately-owned warehouses in the port.

Buyers from all parts of the world attend the wool sales in London and the keenest bidding is experienced. It is calculated that on an average run of years better prices are obtained in London than at any other market in the world.

It is interesting to note that in the reign of Edward I wool was England's greatest export. It was shipped to Flanders for manufacture into clothing, but about the year 1336 Edward III encouraged the Flemish weavers to settle in England. This was the beginning of the great industry of cloth manufacturing in this country and to-day wool is one of England's principal imports. To show their appreciation of the wool industry—but more probably the excellent revenue they were able to derive in taxes from it—the early English kings placed their Chief Counsellor, the Lord Chancellor, on a sack of wool, and this ancient custom of the Lord Chancellor sitting on the "Woolsack" whilst in the House of Lords obtains to-day.

It has been said that London Dock is the real port of London, as it is here that wine, particularly from Oporto, is stored! The famous wine vaults in London Dock were built 120 years ago, when a man's popularity was often judged by the number of bottles of port he could consume at one sitting. The length of the rails in the gangways in the vaults is 28 miles, and nearly 3 million gallons of wine can be stored at one time. In addition, there are 5¼ acres of brandy vaults capable of storing at one time 120,000 quarter casks. The temperature in the wine vaults is about 60° Fahrenheit, and varies very little on the coldest day of winter or the hottest day in summer.

On the ceiling of the wine vaults may be observed an extraordinary fungus which is entirely absent in the brandy and rum vaults, whose ceilings are as clean as those of a cathedral crypt. If it is true that port wine kept in cask is not so gouty as that kept in bottle the escape of this fungus through the wood no doubt accounts for it, but I cannot pretend to enlighten you on this point.

In the brandy vaults we hold some brandy which has been there since 1870.

SURREY COMMERCIAL DOCKS.

The Surrey Commercial Docks are situated on the south side of the Thames and, including the ponds set apart for the floating of timber, have a total water area of 147 acres, with quayage of over 5¾ miles. They are the finest wood depots in the world and are chiefly used by the Baltic and Canadian trades. Although cheese, bacon and grain are housed here, it is better known as a timber dock. Practically all the soft wood coming to London—timber such as pitch pine, deals, and other woods used for building purposes—is stored either at these docks or at Millwall Docks. There are 112 acres of covered and uncovered storage space for timber and timber ponds 36 acres in extent. When a cargo of timber is landed on the quays, experienced men handle it and pile it away to various marks, qualities and sizes. The work of piling is one demanding skill, which is only acquired after long practice.

The annual import of timber into London is nearly two million tons and the stock in the Authority's docks is about 350,000 tons.

WEST INDIA DOCK.

Hard wood, which includes the furniture timbers such as mahogany, teak, oak, walnut, ebony, satinwood, and other expensive kinds, is stored chiefly at the West India Dock, but large stocks are also accommodated at the Surrey Commercial Docks.

The West India Dock is the chief depot for rum in the United Kingdom, the present stock being about 22,000 puncheons, equal to nearly 50 million half pints of proof spirit—enough to intoxicate the whole population of the United Kingdom if taken at one sitting. The value with duty is about £13,000,000.

The West India Dock is also the principal warehousing centre for sugar, of which London imported 667,000 tons last year.

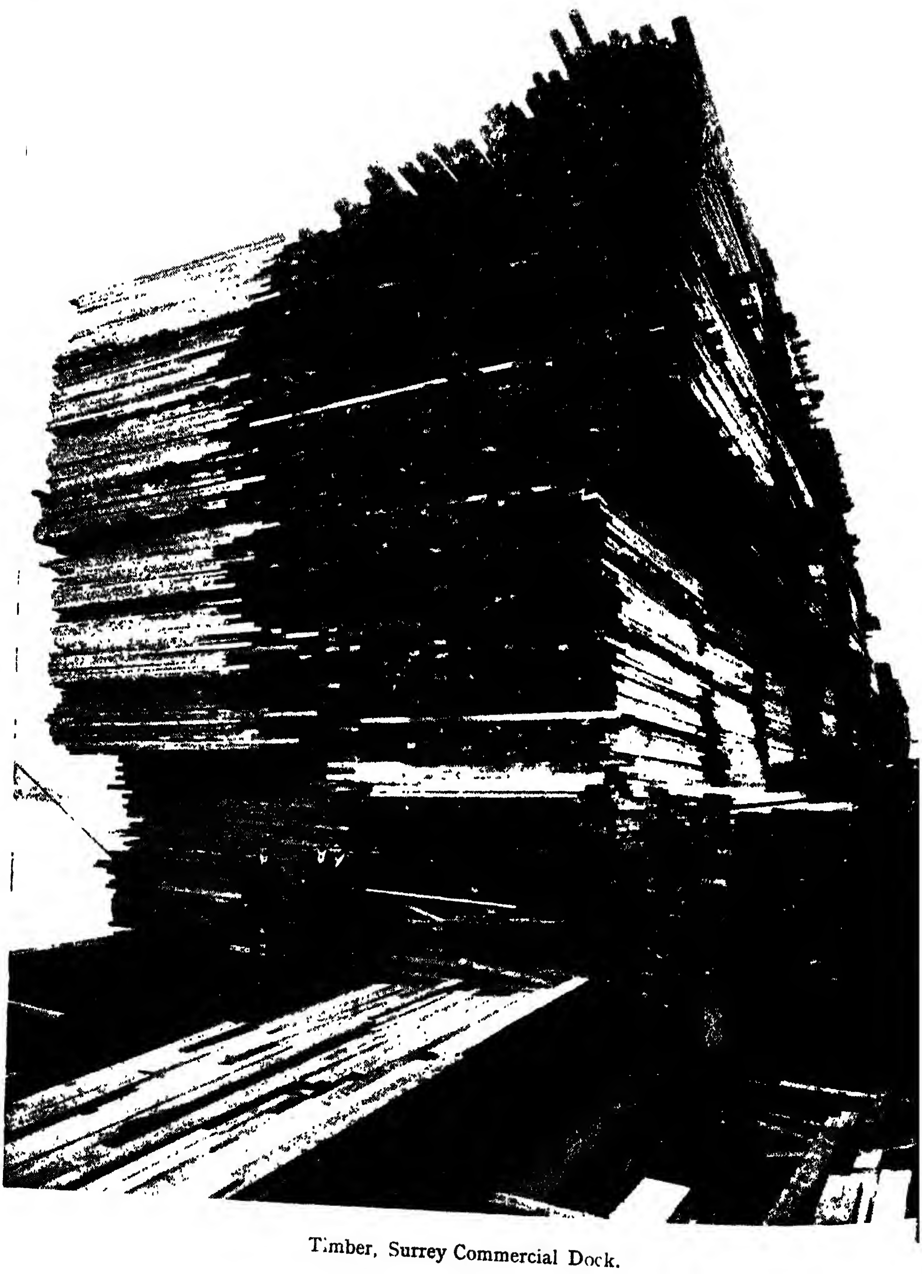
MILLWALL DOCK.

The Millwall Dock has a total area of 231 acres, of which over 35½ acres are water. Grain handling is a special feature of the Millwall Dock, and it is estimated that two-fifths of the about 3 million tons of grain and feeding stuffs coming into the Port of London is handled at this dock, most of the grain being discharged by pneumatic elevators.

The Central Granary, Millwall Dock, will hold about 24,000 tons of grain—sufficient to make 26,400,000 half quartern loaves, a little more than a week's need of the London district (viz., 24,375,000 loaves).

The grain is discharged from the steamer to the warehouse by means of pneumatic tubes by which it is sucked from the hold of the vessel and conveyed by bands into the warehouse.

The grain-discharging appliances at the Millwall Dock are capable of dealing with 500 tons of bulk grain per hour.



Timber, Surrey Commercial Dock.

At the West India and Millwall Docks, which are situated about two miles from the city, the Authority have decided upon a scheme of development in order to render these deep-water docks and quays available to larger ships. The West India and Millwall Docks are therefore being remodelled and unified by making three new ship passages connecting the Millwall Dock and South West India Dock, and West India Dock, and by making a new river entrance at Blackwall 584 feet long, 80 feet wide with 35 feet in depth below Trinity High Water, which will serve the remodelled docks.

The new ship passages with a depth of 29 feet of water have been completed and the water area of this system is now 127 acres with over 5 miles of deep-water quays, all of which will be available through the new entrance to vessels up to 15,000 tons. To bring the equipment and quays into line with the modernised docks a series of single and double storey sheds, with new quay surfaces, rail and crane tracks, and roads are to be built. The cost of the whole scheme will be about £1,500,000.

ROYAL VICTORIA AND ALBERT AND KING GEORGE V DOCKS.

We now come to the largest dock system in London and, incidentally, the largest sheet of dock water in the world, namely, the Royal Victoria and Albert and King George V Docks. These docks, which have a water area of 246 acres, form one continuous sheet of water, the Royal Victoria and Royal Albert Docks alone being three miles long. Ten miles of shipping can be accommodated in these docks.

The docks of the Authority, with the exception of the London and St. Katharine Docks and the Surrey Commercial Docks, are in direct communication with the railway systems of the London, Midland and Scottish, London and North Eastern and Great Western. The Port Authority's railway system consists of about 170 miles of rails and the tonnage dealt with exceeds 1½ million tons annually.

The King George V Dock, which was opened by his Majesty in 1921, has a water area of 64 acres and cost £4,500,000. Its equipment includes over 100 cranes, the lifting capacity of which ranges from 15 cwt to 25 tons. The largest crane in London is the "London Mammoth," capable of lifting up to 150 tons. London's largest liner, the s.s. *Minnewaska*, of the Atlantic Transport Line, berths in the King George V Dock and runs between London and New York.

There are to-day over 45,000 tons of tobacco in the port, the value of which, including duty, is about £60,000,000. This tobacco is equal to about 1,600 million ounces, or sufficient to supply the *male* population of Great Britain (21 million) with one and a half ounces a week for a year. The total yearly import of tobacco into the United Kingdom is about 95,000 tons, 16% of which is produced in the British Empire. A few years ago the British Empire only produced 4 to 5%.

Export Shed, Royal Albert Dock

King George V Dock, showing Cranes.

Tobacco Warehouse, King George V Dock, showing Underhung Crane

Discharging Chilled Beef, No 35 Shed, Royal Albert Dock.

The chief frozen meat stores in the United Kingdom are situated in the Royal Victoria and Albert Docks system, accommodation being available for one million carcasses of sheep. New berths for the discharge of frozen and chilled meat have been constructed recently. Each berth is equipped with all necessary handling appliances, sheds, roadways and railways.

At the cold sorting floor, Royal Albert Dock, meat is taken out of the ship's hold by means of cranes and put on to conveyors, or endless belts, sorted in a refrigerated warehouse and passed to the cold storage chambers proper by another set of endless belts or delivered to insulated vans for Smithfield Market or insulated railway wagons for the provinces. In short, the meat is subjected to the minimum amount of handling and scarcely comes into contact with the atmosphere outside.

Cold Sortin Warehouse, Royal Albert Dock

The capacity of the Authority's cold stores in these docks and elsewhere is now equal to 1,150,000 carcasses of sheep, or 28,750 tons, while cold storage equal to a further 2¼ million carcasses is available elsewhere in the port. During the war these great stores were a national asset, and although the public were on strict rations this accommodation plus the accommodation at other ports was at times insufficient to meet the demands of the Food Controller.

The consumption of meat, i.e., beef, mutton and lamb, in the United Kingdom is about 2 million tons yearly, or 2 lbs. per head per week of the population.

Roughly, half is imported and half home-grown, the actual percentages being 45% imported and 55% home produced. Before the war only about one-third was imported; last year the total importation was 950,000 tons. London's share was 687,500 tons or 70%, the equivalent of over 27½ million carcasses of sheep. From 80 to 85% of the meat marketed in London comes from overseas, so that only one Londoner out of seven can now reckon upon having British-fed meat to eat.

In 1927, 562,867 tons of provisions were inported into London. From New Zealand alone London imports over 60,000 tons of butter and 75,000 tons of cheese yearly.

TILBURY DOCK.

The Tilbury Dock, which has a water area of 90 acres, shares with the King George V Dock the distinction of being the deepest dock in London, being 38 feet to 42 feet in depth. The "crack" liners of the Orient Company, the P. & O., and other important lines have their homes in this dock.

Owing to the increasing size of the ships using the Port of London, it has been decided to construct a new dry dock on the south side of Tilbury Dock. Its dimensions are 750 feet in length (capable of extension to 1,000 feet at any future time when required), 110 feet in width and a depth of 37½ feet on the blocks, and it is expected that the work will be completed this year.

The Authority are also constructing a new entrance lock at Tilbury Dock, 1,000 feet in length, 110 feet in width and 45½ feet deep at Trinity High Water. The entrance lock is expected to be completed next year and will be able to accommodate the largest ship afloat, viz., the s.s. *Majestic*. The cost of the new entrance lock and dry dock will amount to £2,400,000.

Near the Tilbury Dock the Authority have constructed a deep water jetty for the accommodation of vessels discharging part cargoes. The jetty is 1,000 feet long and equipped with the most modern appliances. It is directly connected with the London, Midland and Scottish Railway, and goods can be temporarily accommodated in the two-storey warehouses on the jetty itself.

One of the most interesting schemes, however, to those who travel overseas is the new passenger landing stage at Tilbury which the Authority is constructing in conjunction with the London, Midland and Scottish Railway Co.

Hitherto the passenger facilities in the port have been inadequate, as those who embark and disembark can testify.

In their programme of developments the Authority up to now has been compelled to give preference to the more pressing needs of commerce, but attention is now being paid to the needs of the passenger, and it is anticipated that, given adequate and comfortable facilities, the passenger traffic of the port will greatly develop.

The landing stage will be 1,142 feet long with a depth of water alongside of 35 feet below low water at ordinary spring tides, so that some of the largest liners

may berth there at all states of the tide. It will be a floating structure adjacent to the new railway station which is being built by the railway company. An important feature will be a commodious Customs and Baggage Hall which the Authority are constructing.

Every possible convenience will be afforded for the comfort and despatch of passengers.

A service of express trains to and from the Metropolis will be provided by the railway company, and it is expected that the journey will occupy about forty minutes.

TILBURY HOTEL.

There are several hotels in the docks belonging to the Authority. The principal is the Tilbury, and I take this opportunity of advertising it. Anyone interested in shipping could spend an enjoyable week-end at this hotel watching the ceaseless shipping traffic passing up and down.

DISTRIBUTING FACILITIES.

A glance at the map of the country will reveal the network of railways connecting the port of London with the provincial centres. London's distributing facilities and transport connections are unrivalled. All trunk railway lines, the main road services and coasting and continental shipping lines, radiate from London.

AMBULANCES.

The Authority have an excellent and well-trained staff of men, and provide all the equipment for dealing with accidents in the docks. They have a number of motor ambulance wagons, and call boxes are placed in conspicuous places about the docks, so that in the event of an accident there may be as little delay as possible in rendering assistance.

POPLAR HOSPITAL FOR ACCIDENTS.

Opposite the entrance to the East India Dock is the Poplar Hospital for Accidents. This is the principal hospital used by dock labourers. It was founded by the East India Dock Company seventy years ago, and is mainly supported by the shipowners and merchants of the port, the Authority itself and the individual members contributing generously to its maintenance. I have the honour of being the Acting Chairman.

I have mentioned the Poplar Hospital to remind you that the operations of a great port invariably bring in their train accidents and sickness to the men who do the work, and that the former dock directors and the present Authority have not neglected their duty in helping those who require it. Indeed, at this beautiful hospital (for it is beautiful) patients come in not only from the docks but also from all the ship-building and ship-repairing yards

and from the factories in the neighbourhood. One thousand accidents and medical cases are treated each week.

HEAD OFFICE.

In an undertaking of the magnitude of the Port of London Authority it is necessary to have central offices where the headquarters staff can be housed and work in touch with each other. Prior to 1922 half the staff were scattered about the city in rented offices. On the 17th October, in that year, the Authority's new head office in Trinity Square was opened by the then Prime Minister, Mr. Lloyd George. The building is considered to be worthy of the greatest port in the world.

Although I have only dealt very briefly with the ramifications of the Authority's dock business, I hope I have said sufficient to show you the magnitude of the undertaking and the greatness of London's trade, and I venture to say that great as the trade of the Port of London is to-day the zenith has not yet been reached.

The sole aim of the Port Authority is to maintain London as the premier port and market of the world I cannot help feeling that had the Authority not been created this position would not have been maintained and that possibly it would have been lost to a continental rival which would have been not only a commercial, but a national, disaster.

The following lines, written by the poet Cowper in the 18th century, are true to a far greater extent to-day :-

> "Where has commerce such a mart,
> So rich, so throng'd, so drain'd, and so supplied
> As London—opulent, enlarg'd and still
> Increasing London ? Babylon of old
> No more the glory of the earth than she
> A more accomplished world's chief glory now ! "

DISCUSSION.

SIR CYRIL KIRKPATRICK, M.Inst.C.E., desired to say how much he had enjoyed the author's description of the Port and its activities. It was not altogether new to him ; he had seen some of the actual places himself. In listening to the lecture he had been reminded of his own happy experience of the Port Authority during the twelve years for which he was Chief Engineer. Port Authorities in general rather looked at their engineers askance because they spent money, but he himself was of opinion that ships were going to get bigger and bigger, and Port Authorities would have to spend more and more money if they were not to be left behind. The Port of London Authority had taken the bull by the horns, and was going to reap the benefit. He hoped it would prosper in the future as in the past.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., said that he had listened to the lecture with very much interest, and he wanted, on behalf of the Council of the Royal Society of Arts, to thank the author of the paper. He had, however, a bone to pick with him, for while Mr. Estill had mentioned that wonderful hospital of his,

the Poplar Hospital for Accidents, he had quite forgotten that still more wonderful hospital in the Royal Albert Docks—the Seamen's Hospital. He had also a bone to pick with the Chairman—a delicate thing to do—for he had insulted the "brothers of Trinity House"! However, the Chairman was an old friend and colleague, and he forgave him, but he would remind him that all these wonderful docks that had been built would not have had a ship in them had it not been that the Elder Brethren had lit the estuary of the Thames. A great deal had been said about the organisation of the board of management of the Port Authority. He agreed with every word the Chairman had said. He himself had sat on that board for 15 years, and for eight years he was chairman of one of its chief committees. It was a very wonderful body of men, all engaged in the various activities which had been so eloquently described that evening. All of them had different interests to protect, and therefore were somewhat in opposition to one another, though they all worked together for the good of the Port of London. A better organisation he had never known. He was talking to a former chairman the other day, and asked him whether he would be right in saying that the average attendance at the meetings which used to be held once a week was between 18 and 22 out of a total, then, of 26 members, and the reply he got was that he would be right in saying it was 22. Not one of the members got a single penny for attendance (though, incidentally, there was a good lunch). Something had been said about the organisation in its beginnings, and perhaps he might be permitted to say that the organization emanated from the brain of two men, namely, Mr. Lloyd George, then President of the Board of Trade, and Lord Devonport, then Financial Secretary to the Board. Those two men must have the credit of bringing the organization into being. Both of them were men of vision and knowledge, and the work had been ably carried on by the Chairman, whose portrait they had just seen on the screen. With regard to the dredging of the river, the slogan for all dock authorities was, "Dredge rivers and entrances and build docks, and the ships will come." If the entrances were not dredged and the docks not built, the ships could not come. The speaker suggested that a glance at the Upper Pool from London Bridge would surprise many people. Above the Tower Bridge there were ships of six or seven thousand tons. If such a thing had been prophesied thirty or forty years ago the prophet would have been laughed at. It was the dredging of the river which had brought it about. That was vision again on the part of the Port Authority which spent large sums of money on the project. Mention was made of the width of dock entances. There had always been trouble with dock authorities as to how wide an entrance was to be. In the case of King George's Dock, some wanted the entrance built 85ft. wide, some 90ft., some 110ft., and a compromise was reached at 100ft. If it had not been for that compromise on a considerable width these big ships mentioned by the lecturer would not be entering the dock to-day. He had been interested in the figures relating to the imports of mutton. He used to say that if the frozen sheep that were passed through London in one year were put in single line ahead (head to tail) they would reach from here to New Zealand, with two or three thousand miles to spare. He again thanked the lecturer for a most instructive and stimulating description.

Mr. F. W. Davis said that the lecturer had fully explained the necessity for these improvements and increased facilities. It had been the speaker's privilege to have been connected with these works in an engineering capacity since their inception at the West India and Milwall Docks two and a half years ago. The works had been carried on by day and night and had afforded much-needed employment to a large number of men. The actual number of men employed on the construction had reached nearly three thousand, and of these 60 per cent. were ex-service men.

All the materials, except timber, were of British origin or production, and, where possible, preference had been given to colonial over foreign timber. Good progress had been made by the contractors entrusted with the work, and they had tackled the heaviest tasks with great courage and enterprise. It was practically certain now that the whole of these extension works would be completed within the coming year. There were several miles of quays, now practically idle, which would be made available for new business, and he could visualize Mr. Estill very shortly thirsting for the great post-war expansion in trade predicted in that room ten years ago by a former lecturer on the Port of London.

THE CHAIRMAN, in closing the meeting, said that he was sorry Sir Arthur Clarke had gone, because Sir Arthur had remarked that if it were not for the lighted estuary there would be no docks, and he had wanted to remind him that if there had been no docks there would have been no destination to which to light the ships! Sir Arthur was an old member of the Authority and had done a tremendous amount of work on its behalf. One speaker had remarked about larger ships But he (the Chairman) believed that ships were now very nearly as large as it was possible to build them, and for the next stage in development he looked to aeroplanes. He rather thought it would be a mistake to look forward to very much larger steamers than there were at the present time. He called upon the audience to accord a hearty vote of thanks to Mr Estill for a very interesting and instructive lecture

The vote of thanks was carried unanimously.

MR. ESTILL briefly expressed his acknowledgments

THE SECRETARY (MR. G K MENZIES), in proposing a very hearty vote of thanks to Mr. Thomas Wiles for his conduct of the Chair, drew attention to one feature of the historic room in which the Society assembled, as it showed the high respect the Society had always had for Father Thames. When the room was built, 150 years ago, the artist was instructed to decorate it with pictures symbolizing arts, manufactures, and commerce, and to symbolize commerce the artist took Father Thames. The speaker pointed to the painting of Father Thames on the east wall, as he was represented, with attendant nymphs, 150 years ago

The vote of thanks to the Chairman was also carried unanimously

MR. WILES, in acknowledgment, said that his duties had been easy and pleasant, and he only hoped that the lecture would serve to widen the interest in the river and Port of London.

The proceedings then terminated

NOTES ON BOOKS.

TOUCH TYPEWRITING FOR TEACHERS. By Maxwell Crooks London: Sir Isaac Pitman and Sons, Ltd 7s. 6d net.

This book should be welcomed by all teachers of typewriting, both those who belong to what the writer calls the old-fashioned school of typewriting instructors, and those who have, or think they have, modern views on teaching the subject. It is highly probable that after reading the book many teachers will feel the need of some additional training on the lines indicated. It is refreshing to find a book on method, written specifically for commercial teachers. Typewriting texts have almost invariably been written for the use of students, and Mr. Crooks is to be thanked for his effort to assist the teacher directly and the student indirectly.

The book requires and deserves very careful reading, and it should give rise to much thought and some controversy. This is all to the good, since it is inadvisable that a text book should tend to stereotype teaching methods to such an extent that individuality in method is stifled.

For some years now, there has been a considerable change for the better in the teaching of typewriting. The change has been gradual too gradual. Even to-day there are many teachers who have not been converted to "touch" methods, and there are others who, while professing conversion, have misunderstood what is implied in the method, and have not, in reality, been teaching it. To all such the book is commended with the hope that reading will be followed by a whole-hearted attempt to experiment along the lines suggested. When this is done there can hardly be any doubt as to the result.

The course as outlined appears to be well conceived and most chapters are full of "meat." The most praiseworthy features appear to be the writer's insistence upon a good mastery of the keyboard before students proceed to documentary work or to letter writing, and the separation of the subject, particularly in the early stages, from the teaching of office routine. At any time this last-named subject is of very questionable utility in schools, and in any case it should not be associated with the teaching of elementary typewriting The slow rate of progress of many students is undoubtedly due to the non-observance of these principles enunciated by Mr. Crooks, coupled with a natural desire on the part of the student to get on to something more showy than mere keyboard drill

The book should help teachers to realise that the touch method has not only been justified by experience, but that the days of the "sight" method are numbered

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 10.—PROFESSOR CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., "The Domestic Smoke Problem—Practical Solution."

JANUARY 23.—SIR HENRY A. MIERS, F.R.S., "Museums and Education." THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., will preside

JANUARY 30.—GEORGE FLETCHER, "The Shannon Scheme and its Economic Consequences."

FEBRUARY 6. SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture) SIR GEORGE SUTTON, BART., Chairman of Council, will preside

FEBRUARY 13.—CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms and their Insect Visitors"

FEBRUARY 27. A. F. SUTER, "Resins."

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., "Modern English Architecture."

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced: –

JAMES MORTON (of Morton Sundour Fabrics, Ltd.), "History of the Development of Fast-Dyeing and Dyes"

SIR GERALD BELLHOUSE, C.B.E., H.M. Chief Inspector of Factories, Home Office, "Safety in Factories."

J. F. CROWLEY, D.Sc., B.A., M.I.E.E., "Recent Developments in Vegetable Oil Extraction."

LADY INGLEFIELD, "Lace."

INDIAN SECTION

Friday afternoons, at 4.30 o'clock.

FEBRUARY 8.—CAPTAIN E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., "The History of the Indian Marine." VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., will preside.

MARCH 8. W. H. MORELAND, C.S.I., C.I.E., "The Report of the Royal Commission on Indian Agriculture from the Historical Standpoint."

APRIL 12.—A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

MAY 10.—P. JOHNSTON SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture)

CANTOR LECTURES

Monday evenings, at 8 o'clock

C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." Three Lectures: January 21, 28 and February 4

LECTURE I.—THE USE OF COAL IN ITS RAW STATE. Historical introduction—Production and distribution—Sampling and analysis—Efficiency of utilisation—Steam raising—Pulverised fuel—Furnaces and process work—Domestic heat production.

LECTURE II. HIGH TEMPERATURE CARBONISATION PROCESSES AND COKE TREATMENT. Gas manufacture—Purification, blending and sizing—Steaming—Oil injection—Total gasification.

LECTURE III. LOW TEMPERATURE CARBONISATION. LIQUEFACTION OF COAL.—Low temperature carbonisation—Internal and External heating—Hydrogenation process—Synthetic processes—Combustion of oil

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic Movements in Asia." Four Lectures: April 15, 22, 29, and May 6

SHAW LECTURES

Monday evenings, at 8 o'clock.

SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories 1898-1927, "Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4

LECTURE I.—The "Looks" of the People.

LECTURE II.—Twenty-five Years' Experience of the Notification of Industrial Diseases.

LECTURE III. Twenty Years' Experience of Compensation for Industrial Diseases.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 7..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Dr. Oscar Faber, "The Expansion and Contraction of Building Materials due to Temperature, Humidity, Stress and Plastic Yield." Award of Prizes and Studentships.

Chemical Industry, Society of, Burlington House W. 8 p.m. Mr. J. Ivon Graham, "The Action of Hydrogen upon Coal." (Joint Meeting with Fuel Section).

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. C. H. Karius, "The First Crossing from the Fly River to the Sepik, New Guinea."

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m.

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin. Lecture II - Mountains of Accumulation."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. W. Bell Dawson, "The Hebrew Calendar and Time Periods."

TUESDAY, JANUARY 8..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. T. P. M. Somers, "George the Fifth Bridge, Glasgow."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters, with particular reference to those for special purposes."

At the Royal Technical College, Glasgow. 7.30 p.m.

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Mr. J. Calderwood, "The Diesel Engine for Passenger Ships and Fast Cargo Liners."

North East Coast Institution of Engineers and Shipbuilders, at Cleveland Institution, Middlesbrough. 7.30 p.m. Informal discussion on a Shipbuilding Subject, opened by Mr. W. T. Butterwick.

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. W. H. Fordham, "Geophysical Surveying."

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Prof. F. L. Hopwood, "Experiments with High Frequency Sound Waves."

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Mr. W. N. Edwards, "Microscopical Study of Fossil Plants."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Mr. Alexander Wood, "Sound Waves and their Uses. How Sounds are Recorded and Reproduced." [Lecture VI).

Transport, Institute of, at the University, Bristol. 5.40 p.m. Mr. M. Arnet Robinson, "Coastal Liner Services."

At 200, Buchanan Street, Glasgow. 7.30 p.m. Mr. R. F. Smith, "Co-ordination."

WEDNESDAY, JANUARY 9 Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. Archibald Page, "The Development of the Generation and Distribution of Electric Power in the British Isles."

Fuel, Institute of, at Burlington House, W. 6 p.m. Mr. H. A. S. Gothard, "The Application of Pulverised Fuel Firing for Lancashire Boilers."

Geological Society, Burlington House, W. 5.30 p.m. Prof. Dr. O. T. Jones, "The History of the Yellowstone Cañon, Yellowstone National Park, U.S.A."

Metals, Institute of, at Thomas' Café, High Street, Swansea. 7 p.m. Mr. G. E. K. Blythe, "Pulverised Coal in Metallurgy."

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Mr. Conrad Beck, "Lenses."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. Robert Campbell, "Mountains and their Origin." Lecture III "Mountains of Accumulation." (Continued).

United Service Institution, Whitehall, S.W. 3 p.m. Mr E. J. Foley, C.B. "The Board of Trade and the Fighting Services"

Wireless Technology, Institute of, at the Engineers' Club, Coventry Street, W. 7 p.m. Mr. J. Prechenfried, "Picture Transmission."

THURSDAY, JANUARY 10 .Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Prof B. Melvill Jones, "The Performance of the Streamline Aeroplane."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Capt. J. M. Donaldson, and Capt. J. G. Hines. "A Study of the Future Development of Demand and the Economic Selection, Provision and Layout of Plant, as illustrated by Telephone Systems on the one hand and Power Systems on the other"

At University College, Dundee. 7.30 p.m. Mr. W. M Mackay, "Static Rectifiers."

Historical Society, Royal, 22, Russell Square, W.C. 5 p.m. Prof Dr. B H Putnam, "The Transformation of the Keepers of the Peace into the Justices of the Peace (1327-1380)"

Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Prof. Dr. A. L. Mellanby, "The Essentials of Engineering Education"

At the Engineers' Club, Manchester. 7.15 p.m. Mr W. J. Kelly, "Shoe-Making Machinery"

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Mr H. C. Lancaster, "The Lead Industry."

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Mr. B. Campbell, "Nitrocellulose Lacquers"

Physical Society and Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 8 p.m. Mr. A. J. Bull, "Some Colour Problems in Photo-Engraving."

Refrigeration, British Association of, at the Institution of Mechanical Engineers,' Storey's Gate, S.W. 5.30 p.m. Mr. G. W. Daniels, "Some Possible Developments in Marine Refrigeration."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Prof. Dr. W. Martin, "Jan Steen."

FRIDAY, JANUARY 11 ..Astronomical Society, Burlington House, W. 5 p.m.

Chemical Industry, Society of, at the Royal Society of Arts, Adelphi, W.C. 8 p.m. Meeting of the Chemical Engineering Group.

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. "The Rational Utilization of Coal." (1) Mr. W. J. Drummond, "Coal Used in its Raw State" (2) Dr. W. T K. Braunholz, "Fuels obtained by the Treatment of Coal."

Oil and Colour Chemists' Association, at Milton Hall, Deansgate, Manchester. 7.30 p.m. Dr. J. J. Fox, "The Examination of Paints."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Mr. L. C. Wharton, "Dialect Developments."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. Robert Campbell, "Mountains and their Origin." Lecture IV. "Structures of Folded Mountains."

Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Mr. J. McDougall, "Canvassing as an Adjunct to Trade."

THE MODERN WELDLESS STEEL TUBE.

HOW IT HAS INTRODUCED A NEW PHASE OF MANUFACTURING.

In these days of keen competition, more than ever before, it is important that engineers and manufacturers should be fully informed as to developments in methods of manufacture; but now and again we find the adaptability of certain processes so rapidly encroaching upon established practice that many opportunities are lost before advantage is taken of the new conditions.

Such is the position of the weldless steel tube to-day. Manufacturers are so accustomed to look upon it merely as a "tube" in the accepted sense of the word, that they have not fully realised the possibilities of tube drawing processes in other directions.

The modern weldless steel tube is a very different thing from its prototype of a few years ago. It represents a method of manipulating steel into almost every conceivable shape. In one particular mill no less than 800 different shapes, or "Special Sections," are drawn, apart from the usual range of sizes in the round. Many of these special sections are used, not as "tubes," but as structural components, being either cut down to specified size or manipulated into any conformation desired; and the advantage of the multiplicity of shapes available is multiplied by the forms of manipulation that may be applied to them. They may be tapered, butted, bent, screwed or tapped, trapped, bulged or reduced, spun, flanged, slotted, domed, brazed, welded or soldered, plated, coppered, or galvanized.

The importance of this highly-specialised process to engineers and manufacturers cannot be over-estimated particularly as it is an economical process, productive of clean, well-finished work which compares favourably with any other method of production.

As compared with pressings and stampings, the modern weldless steel tubular product gives a better finish at practically the same cost.

As against castings, tubular processes have the advantage of better surface and less machining, and they do not destroy the ductility of the metal.

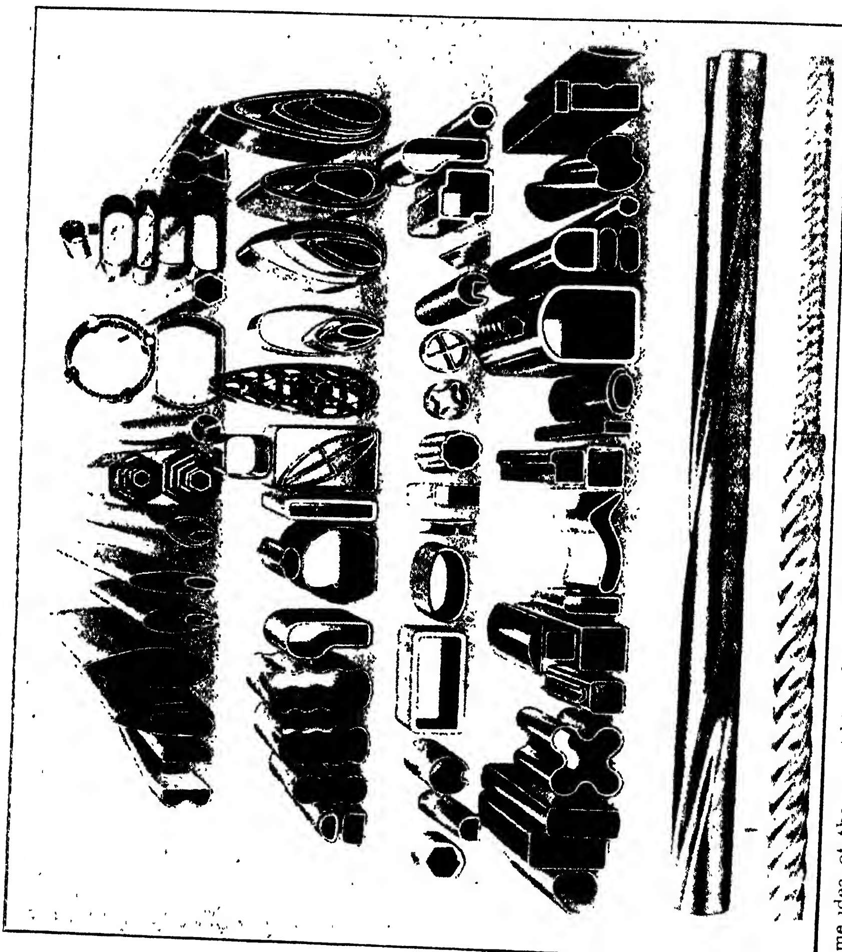
As a substitute for solid metal, they eliminate costly machining operations.

For articles previously made from wood, tubular construction offers greater strength and durability, without added weight, and cuts out a lot of finishing work.

The modern weldless steel tube is applicable to the requirements of hundreds of industries, many of which have already discovered in it a means of simplifying production, increasing output, reducing costs, and improving quality and finish. Tubular products are used in the construction of thousands of articles, and are in daily requisition for component parts of plant and machinery.

The possibilities of the modern weldless steel tube are only beginning to be realised. The essential fact is that we have a process by which steel of all grades, from "low carbon" to chrome molybdenum and stainless, may be economically worked—a process that bids fair to revolutionize manufacture in many directions.

[*See illustration overleaf*]



Some idea of the versatility of the Cold Drawn Weldless Steel Tube for general manufacturing purposes may be gathered from this illustration. It shows a selection from about 800 different Special Sections produced by one firm from stock dies. These Special Sections are adapted in various ways to meet the requirements [illegible]

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, JANUARY 11th, 1929.

All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 16th, at 8 p.m. (Ordinary Meeting.) PROFESSOR CHARLES R. DARLING, A.R.C.Sc I., F.I.C., F.Inst.P., "The Domestic Smoke Problem—a Practical Solution." DR. MARGARET FISHENDEN, D Sc., F.Inst.P., of the Fuel Research Division, Department of Scientific and Industrial Research, will preside.

DR. MANN JUVENILE LECTURES.

The first of the two juvenile lectures annually given under the Dr. Mann Trust was delivered on the afternoon of Thursday, January 3rd, by CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House, on the subject of "Ships"

SIR GEORGE SUTTON, Bt., Chairman of Council, presided.

In this lecture Captain Sir Arthur Clarke related the story of the ship and the sailor from Noah's Ark down to the present time. His story, told in breezy style, was woven round the various types of ships which succeeded each other down the centuries, and the sailors who fought and traded in them—the coracle of the ancient Britons, very similar to that used on the West Coast of Ireland to-day, the Roman galley—a type which survived in the Mediterranean well into the age of steam—the ships of the Norsemen, and the Saxon ships built by King Alfred to fight them at Charmouth and elsewhere, the carrack of the 15th and the galleon of the 16th century, the Spanish Armada, the sea-fights of Blake and Van Tromp in the 17th century, the Barbary corsairs, the broad-side ship of the line and frigate of the 18th century, and finally the age of steam culminating in such leviathans as the *Mauretania* and *Royal Oak*. Sir Arthur Clarke, who began his sea service in the East Indiaman "Geraldine Paget" in 1872, added a personal touch to a most interesting lecture by illustrating some of his remarks from actual incidents which had occurred in the course of his long experience.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

WEDNESDAY, DECEMBER 5TH, 1928.

THE HON. SIR CHARLES A. PARSONS, O.M., K.C.B., LL.D., D.Sc., F.R.S., in the Chair.

The following paper was read:—

FUEL FOR SHIPS.

By SIR EUSTACE TENNYSON D'EYNCOURT, K.C.B., D.Sc., LL.D., F.R.S.

The Royal Society of Arts having invited me in the early part of this year to read a paper on the subject of Fuel for Ships, I agreed to do so, as the subject is naturally one in which I take the greatest interest. I fear, however, that the present is not a very good time for dealing with the question. Several very interesting papers have recently been read, and a good many experiments have been, and are still being, carried out with fuel for ships; thus the matter, in a sense, is in the melting pot. Therefore, at the moment, I can only endeavour to place before you the position as it exists at the present stage, and mention some of the latest developments which have been made.

The whole question is really one of economy for the ship owner, and there are so many factors which differ widely in the many services which ships of various classes perform that it is quite impossible to lay down any golden rule on the subject.

There is, I think, no disagreement whatever about the fact that liquid fuel of one kind or another is the most convenient in every way for use on board ship. The advantages of liquid fuel are chiefly the following:—

It can be easily dealt with and quickly delivered on board without any of the trouble, labour and dirt, and difficulty of stowage, which is so apparent when taking in coal. Liquid fuel can be stowed in almost any position in the ship, and thus spaces which are practically useless for cargo or any other purposes can be used without difficulty for the stowage of liquid fuel. From these fuel bunkers, wherever they may be, it can be readily drawn and delivered, either to the boiler or the Diesel engine, as the case may be.

In the early days of the stowage of oil fuel in bulk, and its use, great apprehension was felt regarding the possible danger of fire; but with the exercise of reasonable care in arranging the stowage and seeing that the containing bulkheads are oil-tight, very little risk has been experienced, and it has been possible to ease the regulations considerably regarding flash point when using oil in ships, owing to the general immunity from accidents which has been experienced in its use. There have indeed been very few fires in ships from

this cause—no more, I think, than occur owing to fires in coal bunkers; so this objection was, at a very early stage in the use of oil fuel for ships, practically eliminated.

On the other hand, in the case of the heavier oils, which become solidified by cold, in a great number of instances ships have to be provided with special heating arrangements to keep the oil in a liquid condition. This, of course, involves a certain amount of expense and weight in arranging the heating coils; but there has been no great difficulty, and the cost has not been in any way excessive.

I had the honour, in the capacity of Assessor from the Admiralty, of attending the Oil Fuel Commission in 1912 and 1913, which was so ably presided over by the late Lord Fisher. The greatest authorities came before that Commission, and as a result the vast advantages of oil fuel for Naval ships, as against coal which had hitherto been exclusively used, became so apparent and were so clearly set forth in the Report, that steps were immediately taken for the provision of oil storage for the navy at various fuel stations, and, practically from that date, every fighting ship in the Navy was arranged to burn oil instead of coal. Ships which were then being designed at the Admiralty to burn coal were altered to burn oil, and some of the older ships were converted for the purpose. It was pointed out that the ease with which oil fuel could be put on board and also delivered to the boilers, saved all the arduous work of coaling and coal trimming, and practically all the work of firing the boilers, which had hitherto absorbed so much labour in our warships. When a ship returned for fuelling, instead of the crew having the very strenuous work of coaling against time, they had a rest while the oil fuel was being taken on board. They were thus refreshed and fit to do any work required of them when the ship put to sea again, ready for action.

The result of the adoption of the recommendation of the Oil Fuel Commission no doubt had a very marked effect on the Naval Campaign of the Great War. Our ships were less time in port; they were able to maintain their speed over long periods to an extent which it was almost impossible to achieve with coal.

It is, in fact, no exaggeration to say that but for the introduction of oil fuel many of the ships built for the Navy with very high power and speed would have been impossible had coal been the only fuel; and had this been so during the war a much longer time would have been spent in port than was the case with oil, so that virtually the numerical strength of the fleet would have been reduced.

Since the adoption of oil fuel, there has practically never been the least question at the Admiralty or in naval circles that liquid fuel is indispensable for Naval ships.

A further advantage of oil fuel as against coal is that, as I need hardly mention, the calorific value of oil being considerably higher, the same weight of oil gives a very much greater radius of action than coal,

The complete adoption of oil fuel for the Navy naturally had its effect on the minds of those dealing with vessels of the mercantile marine; especially with the high speed vessels with large power, which required very big staffs of firemen, trimmers, etc., to run them, and took a long time coaling with the concomitant inconveniences and time in port turning the snip round. A good many of the Atlantic liners were accordingly converted to oil fuel, and new ships were designed to burn oil fuel. For the slower class of boat-- tramps and the like-- it was generally found not economical to adopt oil fuel for raising steam, the extra price of the oil exceeding the saving which could be made by reduction of the crew and the time saved in turning the vessel round. This latter is only a comparatively small percentage of the total time occupied by the usual long round voyage of the cargo-carrying vessel.

These advantages of oil fuel no doubt so impressed all concerned, whether engineers, shipbuilders, or ship owners, that when the Diesel engine became a practical engineering proposition and they found that it only required about half the amount of oil that an ordinary steam engine required when burning oil for steam raising, the tendency was for everyone immediately to look to the Diesel for the great improvements in economy which would result. This development in the use of the internal combustion engine is reflected in the record book of Lloyd's Register. The latest edition gives the following figures, viz.:—

In July, 1919, there were 912 motor ships with total gross tonnage of 752,000 tons.

In July, 1928, there were 2,933 vessels with total gross tonnage of 5,432,000 tons, whilst during the same period vessels fitted for burning oil fuel as recorded in Lloyd's Register record book increased from 5,336,000 tons to 19,053,000 tons. A large number of the ships built during the last ten years were oil tankers—the totals of which increased from 2,929,000 tons in July, 1919, to 6,620,000 in July, 1928. These figures shew the enormous increase in the amount of oil used for various purposes, which is now carried in bulk.

The result of all this is the present terrible state of the coal trade in this country. Not only are we losing the money on our largest export—coal—but money is going out of the country to buy oil fuel, which, generally speaking, comes from non-British countries; and there is as a result an enormous increase in unemployment in this country.

That this is widely realised is now clear; and I may quote some remarks made recently by the Chairman of the Buenos Ayres Western Railway, which are typical of what is happening throughout the world. At a meeting of the company, held on the 23rd October, 1928, he said:—

"From the point of view of our coalfields at home I am sorry to have to report that very satisfactory progress is being made with the development of our oilfield in the Argentine. We consumed last year in our own locomotives and power house our one-third share of the production available. Moreover,

> petrol is now being made on our field, and Diesel oil can, of course, be produced, so that we have at hand the prime elements for the Diesel and petrol engines that we foresee will be required by us, not only on the railway, but on the roads and even in the air, in the future."

Here is another of our markets for coal disappearing, and as I have already said, this is only one example of what is happening far and wide.

From all this it is abundantly clear that no stone must be left unturned to find every possible use and market for our coal, and we must certainly use it as a fuel as far as it is economically possible to do so in all British-owned machinery, including our ships. Unfortunately, a great deal of time has been lost in bringing this aspect before all concerned. So struck was everybody by the economy of the Diesel engine, that early in 1925—that is, about four years ago—Sir Fortescue Flannery said in a paper he read in this hall, that he believed the use of Diesel machinery for navigation would become so common that only for special purposes would the steam engine be able to hold its place. This statement was quoted about three months later by Sir John Biles, at a meeting of the Naval Architects in April, 1925, and he proceeded in a most interesting paper to shew that with the prices then holding (which still approximately hold good to-day) a vessel with the latest type of steam turbine with higher pressure and temperature could be run more economically with coal than a vessel with a corresponding Diesel machinery plant. The fact is, that since the introduction of the Diesel engine with its undoubted economy in burning fuel, great improvements have been made in the economy of steam turbines with suitable high pressure boilers. These improvements have been largely due to the work of our Chairman to-night, Sir Charles Parsons. I think if ship owners had realised the extent to which these improvements had been carried, many of them would not have decided upon Diesel machinery without more thought. This being the case, in view of the serious position of our greatest export industry, it would seem to be a patriotic duty for all who can do so to enquire fully into the possibilities of using coal rather than oil in their ships. The engineers and shipbuilders in this country are, I think, doing everything possible in this direction ; and it is necessary to have the full co-operation of ship owners and coal owners and the blessing—if nothing further—of the Government, to help such a good cause and to restore as soon and as far as possible the prosperity in the most important of our export trades.

All these points were brought out at a recent World Fuel Conference ; but such a flood of information was forthcoming thereat, that it to some extent acted as a smoke-screen and made it difficult for the ordinary man to see the wood for the trees ; but, as has been pointed out by Sir John Biles and others, even at present, with the means at our disposal, coal can be used as a fuel for ships in many cases with greater economy than oil, when burnt in the most economical way. There still remains, of course, the great advantage in all ships which accrues from the use of liquid fuel as against solid. It would be impossible

in this paper to go-into all that had been done by the Fuel Research Board and other investigators in regard to coal and other fuels, whether in the laboratory or on the larger practical experimental scale. In a recent report made by the Fuel Research Board it was stated that even if the low temperature carbonisation of coal could be made entirely successful, it could not be expected to supply suitable oil in sufficient quantity to make this country independent of oil imported from overseas. It appears, therefore, that we are left with the necessity of as far as possible using coal in its solid form; and reducing to a minimum, not only the first cost, but also the cost of conveying it to the furnaces, and burning it to the best advantage.

A great deal of very valuable experimental work both in the laboratory and on a large scale has been done in this direction. Reference must therefore first be made to the use of mechanical stoking appliances. These naturally make for the economical use of coal, reducing the stokehold personnel to a very small number compared with the old method of firing the boilers. The coal must also be placed on board by the most efficient methods of transport. A good deal more has been done abroad than in this country in the way of transporting coal to the ports. Greater use is made of conveyors, with the result that coal is much more quickly dealt with in many foreign ports than it is in this country. This point, it appears, should be specially taken up by the coal owners and shippers in order that the reproach one often hears that ships can be coaled much more quickly in, say, Dutch ports, than in our own East Coast ports, may be removed.

As small coal is necessary, either for use with mechanical stoking in the boilers or for pulverising purposes, plant can be specially developed, as has been indicated in recent papers, by which coal can be pumped along pipes into bunkers much in the same manner as oil is put on board. This method has already been carried out successfully on land with pneumatic plant, and lends itself to development for use in connection with the coaling of ships. With such arrangements and with the adoption of mechanical stokers, which are already being successfully used at sea, a great deal of the man-handling of coal is done away with; and the number of men required in the stokeholds with good mechanical stoking appliances is reduced nearly to that prevailing with oil fuel boilers.

In ships recently built for the Canadian Pacific Steamship Company these mechanical stoking appliances are functioning very satisfactorily, and I understand the owners are very satisfied with the results they are obtaining, both in economy and general convenience. In these vessels boilers are of the water-tube type, some of the ships being fitted by Messrs. Yarrow & Co., and others by Messrs. Babcock & Wilcox. The boilers have a pressure of 250-lbs and are fitted with superheaters. I believe that Mr. Johnson, the owners' General Superintending Engineer, is hoping to publish more information about this matter in the near future; so that I cannot say very much more

in connection therewith at present. In some of the Canadian Pacific passenger ships higher pressures up to 350-lbs. have been used.

A further approximation to the use of liquid fuel in ships is made by the pulverisation of coal. This development, as you know, though still to some extent in the experimental stage, has recently made great advances. A very interesting paper on this subject was read before the Institution of Naval Architects in July, 1927, by Engineer-Captain Brand, R.A.N. Captain Brand gave a great deal of information in his paper explaining the nature of various experiments carried out, and especially those made by the Naval Board in Australia. In the official report of the supervising officers it was stated that they considered the following points had been proved :--

(1) That powdered fuel can be burnt satisfactorily as compared with other fuels for warship purposes.

(2) That it can be conveyed continuously and efficiently from a ship's bunker to a furnace, and the combustion and smoke production regulated as easily as with oil fuel.

(3) That fuel can be delivered into the bunkers easily and efficiently.

(4) The conveying machinery, fuel supply, etc., can be installed at comparatively low cost, without undue loss of power or excessive weight.

In these experiments and in the methods advocated by Captain Brand, the proposal is to carry powdered fuel in bulk in the ship's bunkers; thus doing away with the pulverising plant working on board—some form of which is otherwise necessary in connection with the use of powdered fuel.

In the adoption of such a system there is first of all the question of danger of explosion when powdered fuel is used in this manner, and Captain Brand proposes to eliminate this danger by the introduction of inert gases from the funnel, thus guarding against the existence of an explosive mixture. I cannot help thinking that there will be great difficulty in making any such arrangement practicable. On the other hand, I am doubtful whether the danger is very great, and am inclined to class it with the danger bogey which was so prevalent in the minds of many who feared the consequences of the adoption of oil fuel; and which in the end proved to be easily provided for. The chief objection to the use of powdered fuel in bulk appears to be the difficulty of storage, involving not only arrangements in the ship's bunkers, but also the provision of tanks on shore at various coaling stations; with special provision in both cases to keep the powdered fuel absolutely dry. This provision would involve an enormous outlay and take a long time to establish--just as the arrangements for oil fuel have been gradually developed with storage tanks at various ports all over the world.

In the meantime, until we learn more about the use and storage of powdered fuel, I cannot help thinking that the most practical method of using pulverised coal for ships is to carry the pulverising plant on board and to pulverise the coal as it is required. Various experiments have been made in this direction,

both in America and in this country. You have all probably read about the experimental plant fitted in the *Mercer* under the supervision of the U.S.A. Shipping Board. A great deal was learnt from this; but it all shewed that a good deal has yet to be done to make the arrangement thoroughly successful I think, however, that the experiments carried out in the *Mercer* were perhaps most useful as an object lesson to those interested in the use of coal. America is practically the home of oil fuel, and if they had no coal at all, oil is available in unlimited quantities, at comparatively low prices, for fuelling ships. In spite of this, the Americans saw fit to spend large sums experimenting on the new use of coal as a fuel for ships, although the export of coal is not by any means a vital matter in the trade conditions of the U.S.A. On the other hand, although the matter *is* a vital one to this country, no experimenting on a big scale and with the assistance of the Government has yet been made in the same direction here. At the present time in this country the greatest advance made in the use of powdered fuel has been carried out entirely by private enterprise Several engineering firms have done a great deal of pioneer work in connection with the use of powdered fuel, involving experiments with burners, pulverising plant, with boilers, and with distributors. These include experiments by Messrs. Yarrow & Co., Messrs. Babcock & Wilcox, and Messrs. Clarke, Chapman & Co. The last-named firm seems to have gone a long way towards perfecting burners and pulverising plant, and have been experimenting for quite a number of years. The bulk of the work done here hitherto has been with land installations; and a great number of pulverising plants are now in use in land boilers, in collieries and other works, giving most satisfactory results. Low grade coal of small value, costing often less than 10s. per ton, is being pulverised and used most efficiently and economically for power plants. Based on these practical results, experience with land plants has been used to produce pulverising arrangements fitted to marine boilers, which show very great promise. The first marine plant actually fitted was in a cargo vessel of the Blue Star Line, the *Stuart Star*. One of the four furnace, single-ended boilers was adapted with a "resolutor" mill and "Woodeson" burners, and was in continuous use throughout the voyage to the River Plate and back. The experimental installation gave such excellent results in service, and the Blue Star Line were so satisfied that they ordered the conversion of the double-ended boilers for pulverised fuel; and I understand it is their intention to adopt similar arrangements in one of their passenger liners.

There have been many difficulties to overcome in the use of powdered fuel First of all, a suitable burner had to be designed, and Messrs. Yarrow & Co., Messrs. Clarke, Chapman & Co., and others have developed very satisfactory ones. I do not propose to go into details of the various burners—Peabody, Buell, etc. The same experimenting and research had to be done in connection with oil burners before a suitable type was developed, but the difficulties were

all overcome, and apparently the same measure of success has been reached with powdered fuel burners. To burn powdered fuel satisfactorily it is necessary to have it in a complete state of turbulence in the furnaces and to have a flame which is not too long. This result has been achieved with recent burners, and the Clarke, Chapman Patent Burner can be seen at work in their experimental marine boiler at Gateshead.

Last spring, before the Liverpool Engineering Society, Mr. W. E. Woodeson, B.Sc., of Messrs. Clarke, Chapman & Co., read a paper on "Pulverised Fuel for General and Marine Purposes." This gave a very good and clear account of the work which has been carried out in the development of Messrs. Clarke, Chapman's Pulverising Plant, and I would commend this paper to the attention of anyone interested in the subject, as well as the earlier paper by Captain Brand. Mr. Woodeson describes the experiments made for marine boilers as gradually developed from the use of their plant with land boilers. He also describes the various burners and shews how arrangements have been made to reduce the length of the flame to the proportions required for success in marine installations. He gives the cost of pulverising, which requires about 14-K.W. per ton of coal pulverised per hour; the cost of repairs to the pulveriser itself varying from *2d.* to *8d.* per ton, according to the quality of coal used. In their pulveriser the wearing parts of the machine are easily accessible and can be readily renewed. I certainly think the arrangement for pulverising in their so-called Resolutor machine—which is brought about by impact—is simpler and cheaper than that which has been generally used in America, by rotating balls in the pulveriser.

In the latest machines various kinds of coal may be used—from a good, down to a very poor quality—and the coal may have a considerable amount of moisture in it, amounting to as much as 10 per cent. or even more, and can be dealt with in the pulveriser. Very great fineness of pulverising can be achieved, this being a very important point, in order to get the most perfect combustion.

There is, I think, a great deal still to be done in the matter of coping with the ash resulting from the burning of pulverised fuel, but all these points are being thrashed out by the boiler-makers, especially Messrs. Babcock & Wilcox, who are devoting much attention to the subject.

Finally, there is the question of the entire cost of the arrangement. I am frequently asked by ship owners, especially in connection with tankers and cargo boats, whether in my opinion they should adopt Diesel or steam engines. The question always involves a long investigation into the particular service for which the ship is intended, and the price for the necessary fuel at the different ports or terminals at which the vessel is to call. I may perhaps say that in a good many instances of late a decision has been given in favour of steam when originally a Diesel engine had been contemplated. There have, on on the other hand, been cases where a Diesel instead of a steam engine has

been installed, which shews that the question is one which cannot be settled easily or in an off-hand manner.

With the use of coal in powdered form we have a fuel which in its use and action very nearly approximates to oil. It can be used in suitable water-tube boilers as well as in the Scotch boiler, and can further be adopted for high pressure boilers with high temperatures and the greater resulting economy.

No doubt great improvements will be made in boilers specially designed for the purpose—perhaps with water-cooled walls for the combustion chamber—and as these improvements develop, I look for considerably greater economy with the use of steam and high pressure turbines, with powdered coal as the fuel, than is given in his papers by Sir John Biles.

In advocating the use of steam as against the Diesel engine, and the economy of coal versus oil, it seems to me that in the comparison he gives Sir John has taken a rather high price for coal. His figures shew that a high pressure steam outfit is more economical over a voyage of a little more than 14,000 miles in length. If a lower figure is taken for the price of coal—and I see no reason why it should not be, especially with the use of powdered fuel—its advantages are still more pronounced, and make for a still longer voyage or a greater saving in running costs.

It may be objected that the pulverising plant on board takes up valuable space in the ship, and this is certainly true. The question of stowage of coal, whether for mechanical stokers or for pulverising, calls for a good deal of consideration, and there is room for improvement. It is necessary in every case to have a ready-use bunker in a position immediately over the stokehold; and the coal from the main bunkers has to be conveyed to this ready-use bunker. I believe, however, that it is possible to so design a ship that the main bunkers can be made much more self-trimming towards the ready-use bunker than has generally been done hitherto. In this connection proposals have been made in the case of certain ships in the U.S.A., and I believe the question has received consideration in some designs in this country; but I do not think much has been done in this direction up to the present. Of course, such bunkers occupy valuable space, but if the ship is designed with this point in view at the start, the advantages to be gained are sufficient to warrant the use of some of the space so required. On the other hand, there is no reason why water-tube boilers should not be increased in size—as has been done in the case of oil fuel—so that the number of boilers required may be reduced and the loss of space thus regained, and thereby the adverse economical point of valuable space been taken up can be largely removed.

To sum up the whole situation, there is no question about the convenience or efficiency which can be assured with the use of oil; the great objection being the high cost. If the ratio of cost of coal to that of oil fuel remains as at present, or even if oil costs somewhat less, it is thought that with the improvements which are being rapidly made to use coal and steam in the most economical

manner, there is no reason why it should not be found that it is as unwise economically for British ship owners to arrange for their ordinary cargo ships to burn oil imported from Texas or the Persian Gulf, as it would be for American ship owners to insist on coal for a line of vessels plying from California or the Gulf of Mexico.

In order to develop the use of coal for ordinary British cargo boats, the transport and conveyance of coal to the furnace must as nearly as possible be accomplished in a similar way to that which is done with oil fuel, so as to reduce labour costs to a minimum. This can best be done, first by the use of small coal and mechanical stokers; and a still further advance will be made if the use of powdered fuel can become thoroughly practicable. For the latter, the object must be to arrive at such an arrangement combining, in a suitable water-tube boiler, burners and combustion chamber which can deal with any ordinary type and condition of coal, so that the owner may feel confident that his vessel can successfully operate with bunker coals obtained at any of the ordinary coaling stations throughout the world.

DISCUSSION.

The Chairman said that at the present time a survey of the whole situation was exceedingly important. In electrical generating stations throughout the world there were very few Diesel engines of over one thousand horse-power, the only exception, to his knowledge, being one of 15,000 kilowatt capacity in Hamburg. The obvious question arose what difference existed in the conditions on board ship, and on land, which acted favourably or unfavourably in the comparison between the steam engine and the oil engine, and also between the use of coal and oil. Sir Eustace d'Eyncourt dealt very fully with those and other questions.

There could be no doubt, however, as to some of the conditions on board ship, which could be considered more favourable to Diesels than to steam, and also to oil as compared to coal as fuel under boilers and vice versa. Sir Eustace d'Eyncourt had dealt very fully with these questions, and there seemed no doubt that this important subject required thorough practical investigation. A great deal of money had been spent on low temperature carbonisation, but the development of the burning of coal on board ship had hitherto been comparatively speaking neglected. There was a great deal of spade work to be done as to the best methods of handling the coal on board and into the ship.

Sir John H. Biles, K.C.I.E., LL.D., D.Sc., said the last time he had had an opportunity of speaking on the subject had been on behalf of the Naval Architects and in defence of a paper which he had read as one of a series of papers on the matter which had been so admirably dealt with by the lecturer that evening. The lecturer's judgment in the matter was most valuable; his wide experience, both in connection with the navy and the mercantile marine, must impress one with the value of that opinion.

There were always two views to be taken of a subject. One view could be expressed in adjectives and the other could be expressed in figures. When he had been lured into a discussion with the able supporters of oil and the Diesel engine, he had found himself very much on the side of figures, while his opponents

had been very much on the side of adjectives. In the matter of oil *versus* coal, he had happened to be present at a meeting at which Sir Fortescue Flannery, who was supported by the late Lord Bearsted, had waved the flag of oil and had followed it up by going to the funeral of the steam engine.

The lecturer had pointed out that oil went into spaces into which coal would not go. That was true, but that was not the end of it. One wanted to know what it cost to carry coal in the space in which it was carried, and how much one gained by carrying oil in the space in which it was carried, and whether, even if a bigger ship had to be made to carry the coal, it was not cheaper to make that bigger ship than it was to have a smaller ship and carry oil in the spaces which otherwise could not be used, and make use of the advantage of oil in other ways. He had tried to work that problem out in his own paper and, rightly or wrongly, had come to the conclusion that steam was not altogether dead, and that the advantages which Sir Charles Parsons had been able to bring to the assistance of steam were sufficient, at any rate, to make it not certain that it was dead.

The lecturer had very wisely referred to the work which Mr. Johnson, of the C.P.R., had done. Mr. Johnson deserved a great deal of credit for the courage which he had displayed in undertaking that pioneer work. He was also to be congratulated on his good fortune in having got his owners to follow him in the matter. Johnson had reached a condition with the turbine in which he had been able to get an equal h.p. with two-thirds of the quantity of oil which was required in 1922. The last ship which he (Sir John Biles) had had to deal with belonging to the C.P.R. had been a ship with oil and turbines, but with the development which had been courageously adopted by Mr. Johnson, Mr. Johnson had been able to take off one-third of the consumption of the oil. That was going a good deal towards making the unit of fuel per h.p. nearer to that of the Diesel engine; and when one took into account those things which were to the disadvantage of the Diesel—its first cost and its weight—one was getting in actual practice to the state where the steam engine was at least equal to the oil engine.

With regard to the statement that the Admiralty had come to the conclusion that they had no use for coal, that was not quite true, except for the extreme purposes of the Admiralty, namely, for obtaining the highest possible speed, oil was not indispensable. But the highest possible speed was not needed all the time. It was not needed in peace. The Chairman would approve of the statement that a good deal of the Admiralty work might be done with coal instead of with oil, especially as seemed to be the case now, when burners could be put into water-tube boilers, which could be used either with oil or with pulverised coal. If the Admiralty could use in their avocations alternatively pulverised fuel and oil with the same burner, perhaps they might save a little of the importation of oil which everyone deprecated so much.

Many years ago he had worked on a design in which one of the conditions was that all the coal on the ship should gravitate to the firing station. If that condition of affairs was obtained—where the coal gravitated to the crusher or the pulveriser—there was no more trouble about the flow of the fuel to the furnace than there was in the case of oil being pumped to the furnace by the oil pump.

The paper was an admirable summing up of the whole situation, and it would be of very great use to those who were interested in the subject.

Engineer Captain W. Onyon, R.N., remarked with regard to the safety of powdered fuel in ships, that the lecturer had referred to the question of fires. When oil fuel had been first introduced into the Navy he had happened to be the chief engineer of the first "Dreadnought," which had carried 3,000 tons of coal and 1,400

tons of oil fuel, which they had tried to burn together. The number of fires which had occurred in the ship had never been published, but there had certainly been ten serious fires, without even the captain of the ship knowing anything about them. Perhaps the audience might be rather surprised to know how those fires had been put out. They had been put out with powdered fuel—coal dust and ashes damped! When he had suggested to the Admiralty the introduction of sand into warships for the putting out of fires, he had been looked upon as a lunatic, but now nearly every ship carried a sand box in its boiler room. The introduction of powdered fuel into ships would certainly be delayed until some absolutely reliable method of putting out fires had been designed. If the fuel was dealt with on board ship it was a very different proposition, but if powdered fuel was going to be put direct into the bunkers, very careful precautions would have to be taken against fires, and until those precautions were perfected he could not see himself how powdered fuel was going to be introduced into ships.

He would like to ask the lecturer what amount of foreign matter was found in pulverised fuel at 10*s.* a ton. He could not think it was all coal, and he thought it was uneconomic to pay freight for something which could not be burned and for something which had no calorific value. Fuel at 10*s.* a ton was bought, and the result was that there was a good deal of trouble owing to the amount of slag in the furnaces.

Engineer Captain Brand said reference had been made to the necessity of bolstering up the coal trade, coal being practically the only product in this country which was native to the country and which could be sold outside the country. One would have thought that the Government would have seen years ago, as others who had been working on the question for the last fourteen years had seen, what the coal trade of this country was coming to. However, they had not, and neither had the coal owners. The resuscitation of the coal trade was an absolute necessity for the life of this country. There was also one other feature which was of importance, and that was the resuscitation of the boiler shops of the engineering firms of this country. In going round the country one could not help being struck with the disparity in the distribution of work between the shops of engineering firms according to their design and lay-out. The general introduction of the Diesel engine had meant big foundries and a tremendous number of machine tools, with a high grade of workmanship, to the almost utter abandonment of the boiler shop and, to a certain extent, of the sheet iron trades.

Sir John Biles had for many years been a stout supporter of steam, always backing Sir Charles Parsons. Those two gentlemen had fought the good fight for steam year in and year out, and they had been right. The day before yesterday he himself had had occasion to draw up some figures for a ship of 3,000 h.p. Taking the ruling price for oil, and taking the absolute quotation of 9*s.* 2*d.* per ton for slack coal of 13,250 B.Th.U., and ordinary bunker coal delivered alongside at 14*s.* 9*d.* per ton—on that basis, and taking the results of Sir Charles Parsons' work, as to a large extent exemplified in the work of Mr. Johnson, and using Mr. Johnson's figures of .68 lbs. of oil per shaft h.p. hour, he had found that the oil for that ship, including all charges, based on a consumption of 100 tons of hand-fired coal per day, had worked out at £223, and the pulverised fuel, pulverising on board, taking all charges of every description into account, including disparity in freight and stowage, had worked out at £194.

The time had passed when it would be necessary for Sir John Biles to take the platform on behalf of the steam engine. The steam engine with powdered fuel,

high pressure steam and superheat, had arrived, except in special trades, and those special trades everyone knew.

For marine work, efforts so far made in America and in this country had used the direct or unit system of firing. This had entailed many difficulties in distributing the powdered fuel equally between the various furnaces, thus lowering the over-all efficiency. In addition, the unit pulveriser was fundamentally incapable of maintaining an even efficiency at different rates of burning. In fact, its efficiency was negligible when the quantity of coal fed to the machine dropped to a quarter of the designed output. Very many automatic and mechanical distributors had been designed and tested at the Mare Island Navy Yard, U.S.A., without success. In fact, his experience, and that of all other experimenters, had shown that it was impossible to distribute coal dust borne in an air stream equally among a number of pipes, which probably had slightly different bends and lengths. Many years ago he discarded the direct firing for marine boilers in favour of the bin and feeder system; though for water tube boilers having only one furnace he retained the former. It was gratifying to note that in a paper recently read in America by Mr. Peabody, he advocated for marine work the bin and feeder systems, thus showing that his experience of direct firing on the S.S. *Mercer* and S.S. *Lingan* had converted him to an advocate of a British system of firing. With the latter, it was possible to obtain an efficiency of 83 per cent. at one-sixth and 79 per cent. at seven-sixteenths of the rated boiler output. The latter might be as high as from 7 to 8 lbs. evaporation per sq. ft. of heating surface.

MR. W. E. WOODESON congratulated the lecturer on his very straightforward statement of the facts. The lecturer had not exaggerated in any shape or form the position with regard to pulverised coal or oil.

With regard to Government assistance, British firms had not received a great deal of that. The United States Shipping Board had placed ships at the disposal of engineers who desired to carry out experiments, but private firms in this country had had to do the work on their own initiative. It was very easy to criticise the efforts of the people engaged in the pulverised fuel industry, but it had to be remembered that the whole matter was only in its infancy as far as the actual practical applications of pulverised fuel were concerned. As a result of his experience during the past two years, he was firmly convinced that if the same relative advance was made in regard to pulverised fuel in the next two or three years as had been made in the last two or three years, we should certainly have nothing to fear as a nation. The Union Steamship Company, the Blue Star Line, and other companies, were naturally going through a period of experiment, and those companies deserved every praise and encouragement from the country as a whole for doing so. They were really doing pioneer work, despite the fact that they were merely private firms. Britishers were of such a type that they immediately handed over any information they gained to all and sundry, and therefore the Blue Star Line and the Union Steamship Company could not expect to huve the monopoly of pulverised fuel in the future; other firms would benefit by it. That was why he was of the opinion that the Government should come to their assistance to some small extent, so that our home supplies of fuel could be utilised.

Perhaps he might be allowed to answer the question of Captain Onyon as to the 10s. per ton coal. He had gone round in the *Stuart Star* from London to the Tyne after her last return, when she had done a comparative run. Fifty per cent. of her boilers had been fired with pulverised fuel and 50 per cent. with hand-fired fuel. The coal for pulverised fuel had been a mixture of coal at 9*s*. 2*d*. a ton from

Northumberland with 12 per cent. volatile coal from South Wales. Part of the time it had been 12 per cent. volatile, and part of the time it had been all low grade coal. The hand-fired boilers had been shut off completely, and a run of two hours had been made on pulverised fuel. Then the pulverised fuel boilers had been shut down and a run of two hours had been made on hand-fired coal, which was of the best type. They had obtained two revolutions better results with pulverised fuel than they had with hand-fired, and during that time the hand-fired boilers had never been cleaned -which was a very important point.

ENGINEER REAR-ADMIRAL W. M. WHAYMAN, C.B., C.B.E., said he desired to put the problem of coal *versus* oil a little more directly before the audience. One thing which had struck him in listening to the paper had been that the lecturer mentioned that when the Diesel engine had become a practical engineering proposition and it was found that it only required about half the amount of oil which an ordinary steam engine required when burning oil for steam raising, the tendency had been for everyone immediately to look to the Diesel. The stage had already been arrived at when it might be said that a very fair comparison between the Diesel engine and the steam engine was .4 lbs. of oil per shaft h.p. for the Diesel and about .6 lbs. of oil per shaft h.p. for the steam machinery, so that at present, three years after 1925, the difference had been brought down by 50 per cent. That was a comparison between the value of the performances of the two methods of propulsion on oil only. If one went a step further and used coal, one was easily able to realise that the advantages which were claimed for coal in steam machinery were well within view, if not already proved.

The point had been stressed that if all the coal which was in the country was treated with the low temperature carbonisation method, and good results obtained in the amount of oil which was extracted from coal, there would not be enough to go round; but if only the industries of the country could be prevailed upon to use coal for their power supply, and let the predominant amount of oil fuel which was obtained from the coal be used for marine purposes, this country might come very much nearer to the point of being self-supporting.

He would like to call attention to a paper which had been published in last week's *Engineer*, which gave a very good *résumé* of the experience in America, which endorsed the view that the stage had very nearly been reached when the powdered fuel proposition had been demonstrated to be a working proposition. If it could be assumed, as it could be, that coal, in which ever form or method it was burnt to provide the steam power, was at least the equal of oil burnt in the internal combustion engine, and if then mechanical means could be introduced for burning coal for steam machinery afloat, he thought it would form a very serious competitor to oil fuel and the Diesel engine.

MR. CUNNINGHAM CRAIG said he had not had any experience of the use of powdered fuel on a ship, but he had seen what could be done under boilers with powdered fuel—and with powdered fuel of really a most inferior kind. He had seen the retorted residues of a cannel (and a very poor cannel) keeping up a magnificent flame and a magnificent steam pressure in retorting work. When one talked about powdered fuel, one had to consider what kind of powdered fuel. He believed that it would not be economical to powder raw coal and use it as a fuel. To begin with, the storage of powdered raw coal was a difficult and dangerous thing. But there were other kinds of powdered fuel. There came in the great question of low temperature carbonisation. The idea prevalent in this country was that low

temperature carbonisation depended upon the supply of a domestic smokeless fuel. That might be an excellent thing locally, but it was more important to consider the development of a powdered fuel as a residue. That meant that one could work with coal slack. In Scotland at the present day there was something like ten million tons of slack coal produced, and it was almost impossible to get a sale for it. It did not require much pulverising if it was put through certain retorts. Such oil as could be obtained was taken off, and the residue was a powdered fuel which could be used at once, which was safe to store, which was easy to handle, which was of high calorific value, and which would be admirably adapted for use in ships. In that case a very large step would be made towards putting the coal industry upon a firmer basis.

Sir Eustace Tennyson D'Eyncourt, in reply, said that anything which brought before the general public the advantages which would accrue to the nation if the use of coal could be brought about to a greater extent was to be encouraged. For bunkers alone something like thirty million to forty million tons would be used annually in cargo boats, which now were propelled by oil. If the use of that oil could be transformed into the use of coal it would be a huge advantage to the coal trade of this country and would add greatly to the employment in this country.

What was really wanted now was for a ship to be built, making the best use of the latest form of high pressure turbine, and the latest form of burners and boilers, which would give the most economic results, and to try such a ship against a twin ship with Diesel engines. Then, after a period of service, a result would be obtained which all the world could see, and he ventured to think then that coal and steam would come back to their own.

Sir John had accused him of using too many adjectives, but that was a low grade form of verbosity which perhaps the occasion might warrant!

A hearty vote of thanks to the lecturer concluded the meeting.

Dr. G. E. K. Blythe, B.Sc., F.Inst.F., F.R.S. (Edin.), writes:

Being essentially interested in the design and application of pulverised fuel equipment to various types of boilers, I have had pleasure in reading the remarks outlined in Sir Eustace's paper relative to this method of firing.

He did not deal as fully with this subject as one would have expected, in view of the tremendous developments which have taken place in this country during the past two or three years. Sir Eustace's reference to the convenience of oil fuel for use on board ship will naturally meet with approval from many sea-going engineers. Oil fuel is ideal in many ways for steam generation, but it is criminal to use it for that purpose when the same result can be obtained from a much cheaper and more plentiful type of fuel, namely, pulverised fuel. When boiler efficiencies obtained with oil have been duplicated with pulverised fuel having a B.T.U. cost of approximately one half of that of fuel oil, and duplicated in such a way that the operating problem has been no greater than that of the oil burning apparatus, then it is most opportune that the marine engineers of this country appreciated to the full extent the importance of this method of firing. The possibility of the efficient, reliable and safe operation of pulverised fuel on marine boilers is no longer an hypothesis, but an established fact, demonstrated and proved out under test conditions in various parts of this country and also under actual sea service conditions. For some of the marine trade routes, pulverised fuel can in its present state of development be adopted with every assurance of

satisfactory results being obtained, but in others the application needs further consideration and experiments. Messrs. R. and H. Green and Silley Weir, Ltd., in conjunction with the Buell Combustion Company, Ltd., have carried out some very interesting and very valuable experiments at the Falmouth dockyard. As a result of these experiments, they have developed a new type of burner, furnace front and pulverised fuel equipment. Many kinds and grades of coal have been burnt on their plant—coal sent from India, New Zealand and various parts of the world—the successful burning of which has proved the flexibility of the equipment installed. These experiments have upset the popular fallacy among pulverised fuel engineers that external combustion chambers were necessary in order to combust efficiently pulverised fuel. The combustion equipment perfected during the experimental period is fitted flush with the boiler front; refractories inside the furnace tubes have been greatly reduced in area, and as a result of these experiments, "unknown to many engineers," the s.s. *Hororata* sailed from Falmouth on Saturday, the 8th December, with three boilers fired with pulverised fuel and fitted with up-to-date equipment, which has given very satisfactory results. This installation, although unique, will be rendered absolute in the course of three to six months, because of the rapid development in design of equipment

Sir Eustace claimed advantages for oil against coal by reason of the former's higher calorific value, which are turned into a disadvantage when considered from the point of £ *s. d.* Taking a coal of 13,500 B.T U's and oil of 19,000 B.T Us, with a cost price of 20s. and £3 15s. respectively, we at once see that for an extra calorific intensity of 5,500 B.T.U's, one has to pay £2 15s., and fine coal can be purchased for pulverising purposes at a figure much below the one quoted above

The ease of operation does not enter into the question when comparing oil with pulverised fuel, because in many respects the operating problem between the two classes of firing is very similar and will be more so in the near future when it will be possible to convey pneumatically the crushed coal (taken on board in this form) from any bunker direct to the ready use bunker.

Flexibility and reliability of operation with this system has now been proved out on board ship—in fact, the pulverised fuel engineers and experts are using their best endeavours to imitate in every possible respect the operating conditions existing with oil firing. When success has been proved beyond doubt, the rapidity of growth of pulverised fuel aboard ships will be most marked. Further, we shall see in the very near future the marine boiler specially designed for pulverised fuel firing with special regard to the steam raising conditions on board ship

The application of pulverised fuel to high speed and high power vessels lends itself very well on account of its operating flexibility. The main question is one of cost, not only in the installation of the necessary equipment, whether coal or oil, but in the running cost of a vessel and the price of the necessary fuel during the voyage.

Pulverised coal experiments carried out in marine boilers have proved beyond doubt that the quality of the coal is not of the greatest importance and that certain qualities, useless for steam in their ordinary state, prove well adapted to pulverisation.

The greater use of pulverised fuel would, of course, benefit British colliery companies very considerably and a universal return to the use of pulverised fuel on cargo carrying steamers would be received with approval throughout the country in view of the present terrible state of the coal trade. Every avenue should be explored in order to meet successfully the greatest industrial problem the nation has yet been called upon to solve since "the hungry forties" The

country cannot allow whole townships to remain derelict. It should not be beyond the resources of statesmanship to devise a cure.

Sir Eustace's reference to the impact type pulveriser being simpler and cheaper than the ball mill is not in conformity with the experience gained by engineers who have been connected for many years with both high speed disintegrating types ring and roller types and ball mill types of pulverisers. It has been proved that no mill in which the coal is pulverised during its passage from the centre to the periphery of a disc when fixed and moving pins are arranged to intermesh, can be relied upon for consistent and continuous pulverisation; the degree of pulverisation falls off rapidly in some types of mills with the wear of the pins and it is impossible to retain the particles in the pulverising zone for a sufficient length of time. Also the high speed of the discs necessary to effect pulverisation when the pins are new contributes to the cost of upkeep, and, furthermore, the power consumption and maintenance are very high. The writer has had experience with these types of mills when the maintenance charges (cost of upkeep) came out at 3s. 2d. per ton of coal pulverised. Ball mills, when properly designed, have been proved out to be very reliable pulverising mills.

In reply to the above communication, SIR EUSTACE TENNYSON D'EYNCOURT writes:

Since the reading of my paper, some written remarks have been received from Dr. G. E. K. Blythe, B.Sc., etc., which appear generally to bear out and strengthen the arguments used in the paper, in which I endeavoured to point out that with coal costing so very much less than oil as a fuel, even with the great economy of the Diesel engine, *steam* raised by coal burnt in a suitable boiler and finally in the best and most efficient form—namely, in pulverised condition—would beat the Diesel engine burning the high priced oil.

Regarding Dr. Blythe's remarks on the ball mill, no doubt there are very good mills of this description, and experience will show in due course which is the best form of pulveriser.

OBITUARY.

SIR HENRY TRUEMAN WOOD.—We deeply regret to report the death of Sir Henry Trueman Wood, which took place on January 7th at the residence of his son-in-law and daughter, Mr. and Mrs. W. R. Fisher, at Bourne End, in his 84th year.

Henry Trueman Wood was born in 1845. He was educated at Harrow and Clare College, Cambridge, of which he was a scholar. At Cambridge he achieved the rare distinction of twice winning the Le Bas Prize (in 1869 and 1870), which is offered annually for the best English Essay on a subject of General Literature. On leaving the university he became a clerk in the Patent Office, where he laid the foundations of a knowledge of inventions that afterwards became very extensive indeed. He did not remain long in this position, however, for in 1872 he came to the Society of Arts as Editor of the *Journal*: four years later he was appointed Assistant Secretary, and in 1879, on the death of Peter Le Neve Foster, he succeeded him as Secretary, a post which he held for thirty-eight years. Under his guidance the Society gained steadily in prestige and reputation, and the quality of the papers and lectures reached and maintained a very high standard of excellence.

In 1914, with the outbreak of war, the Council were faced with a very grave problem. All societies—nay, society itself—were threatened with unknown dangers. Members, forced from their usual avocations, were compelled to resign in large numbers, and nobody knew what the future had in store. The Council wisely decided to carry on as far as possible in the usual way, and in spite of many anxious times, Sir Henry had the satisfaction of seeing the Society emerge from the period of war little the worse financially for the troubles through which the world had passed.

On his retirement from the Secretaryship, he was elected a member of the Council, and served as Chairman for the year 1919-20. In recognition of his services to the Society he was nominated a Vice-President by H.R.H. the President, under the terms of By-law 73, *b*; and Members of the Council also raised a fund to provide an annual Trueman Wood Lecture, in connexion with which a brilliant series of addresses has been delivered.

Some mention must be made of the "History of the Royal Society of Arts," undertaken by Sir Henry at the request of the Council and published in 1913. Extremely well written, it not only gives an account of the varied activities of the Society from its establishment in 1754 to 1880, when he became Secretary, but is virtually a history of invention during this period. It was a task that required a mind of singularly wide interests and varied knowledge to accomplish, and it contains a wealth of information that he alone possessed. A vast amount of research was required before it could be written, and it says much for Sir Henry's literary skill that he was able to present so readable an account of what in less able hands would have been a mere catalogue of technicalities. He also wrote "Industrial England in the 18th Century," "Modern Methods of Illustrating Books," and "Light," together with numerous articles in newspapers and magazines.

In addition to his work as Secretary of the Society, Sir Henry had a long and wide experience of exhibitions. This began in 1873 with the series of London International Exhibitions organised at South Kensington by Sir Henry Cole. He had also something to do with the Paris Exhibition of 1878 when he edited the Artisan Reports on it; but his chief early experience was in connexion with the Health Exhibition of 1884, when he was Joint Secretary of the Jury Commission; with the Inventions Exhibition of 1885, when he was Secretary of the Jury Commission; and with the Indian and Colonial Exhibition of 1886, when he was Secretary of the Conference Committee and Joint Secretary of the Reception Committee. He acted as Secretary and Commissioner for the private committee which organised the Paris Exhibition of 1889, and was Secretary of the Royal Commission for the Chicago Exhibition of 1893. He was one of the most important witnesses who gave evidence before the Committee appointed by the Board of Trade to enquire into the Participation of Great Britain in Great International Exhibitions, when he strongly advocated the establishment of a permanent department of the Board of Trade to take charge of exhibition work—a policy which has now been adopted.

In 1877, Sir Henry was asked to write a report formulating a scheme of Technical Education for the Committee of the City Guilds which had lately taken up the subject. Reports were also invited from Professor Huxley, Sir John Donnelly, Sir Douglas Galton, Sir William (afterwards Lord) Armstrong, and Sir George Bartley. The suggestions of Sir Henry Wood were practically adopted, and this led to his acting as secretary to the Committee of the City Companies and assisting in their early organisation. In 1879 he was offered the permanent secretaryship, but as he had just become Secretary of the Society of Arts, he declined the post.

For many years he was closely associated with the work of the British Association. He acted as Secretary to Section G (Engineering) from 1878 to 1884, when the Association visited Montreal. After that he gave up the secretaryship but continued to attend the meetings regularly up to 1899.

Outside his official duties, Sir Henry, who had been knighted in 1890, had numerous interests. For a great many years he was a keen student of photography. He was himself an excellent photographer, and was President of the Royal Photographic Society from 1894-96. For many years he served on the Board of Kodak, Ltd., and until recently was Chairman of the British section of the firm. For some thirty years he was a well-known member of the Athenæum and served on the committee, of which he was for some time chairman Amongst his most intimate friends there was the late General J. B. Sterling, whose crushing defeat of Herbert Spencer in a game of billiards drew from the disgusted philosopher his classic remark that such uncanny skill was evidence of a mis-spent youth. Sir Henry was also an athlete, for while at Cambridge he ran for the university in the mile race. In later life he played a good deal of golf, he was captain of the Chorley Wood Club and he was also often on the links at Aldeburgh

Sir Henry had a very wide circle of friends, and in spite of a tongue that could be uncommonly caustic on occasion, he was exceedingly popular. The writer of this notice had the privilege of knowing him intimately for twenty years and remembers with gratitude many acts of courtesy and kindness received at his hands An occasional pose of cynicism did not go far to conceal a warm and generous heart, which, if it was sometimes apt to be a little impatient of stupidity was always ready to appreciate and applaud real worth.

Κοῦφά σοι χθὼν ἐπάνωθε πέσοι

SIR CHARLES HERBERT THEOPHILUS METCALFE, BT.—Sir Charles Metcalfe, who died suddenly at his home at Winkworth Hill, Godalming, on December 29th, at the age of 75, was the only child of Sir Theophilus Metcalfe, fifth baronet, of the Bengal Civil Service. He was born on the 8th September, 1853, and was educated at Harrow, where he played for two years in the football XI, and afterwards at University College, Oxford, where he got his "blue" for Rugby football, and also ran for Oxford in the quarter mile in two successive years. In the schools he took a third in classical moderations and a second in law. Oxford was a pivotal point in his life as it was there that he formed a close and life-long friendship with Cecil Rhodes, who went up to Oriel about the same time, the late J. R. Maguire of Merton being another contemporary. When Cecil Rhodes a few years later obtained the grant of a Royal Charter for the Company which he formed for the purpose of extending the sphere of British influence into Central Africa, he undertook to extend the railway northwards from Kimberley, the existing terminus, and indeed the earthworks for the northern extension were begun within a week of the signing of the Charter by Queen Victoria. Sir Charles Metcalfe's firm, Sir Douglas Fox and Partners, surveyed and supervised the construction of the whole of the railway from Kimberley to the Congo, as well as the Beira and Mashonaland Railway, which provided Rhodesia with an alternative route through Portuguese East Africa. Sir Charles Metcalfe was mainly responsible for the line which the railway actually followed and the whole scheme was completed under his personal supervision. He remained the trusted adviser of the British South Africa Company in railway matters up to the time of his death. Sir Charles, who succeeded to the baronetcy in 1883, had been a Fellow of the Royal Society of Arts for nearly 40 years, and since

1921, had been a valuable member of the Dominions and Colonies Section Committee, whose meetings he regularly attended. He also took part from time to time in discussions on engineering subjects at the Society's meetings.

SIR CHARLES WRIGHT MACARA, BT.—Sir Charles Macara, who died on January 2nd, in his 84th year, had been for many years a leading figure in the cotton industry. He was largely responsible for the Brooklands Agreement of 1893, which marked an epoch in the relations between capital and labour in the cotton trade, and was also the founder of the Federation of Master Cotton Spinners' Associations and of the International Federation of Master Cotton Spinners' and Manufacturers' Associations.

He was born in the Fifeshire village of Strathmiglo on January 11th, 1845, his father being the Free Church Minister there. He was educated in his native village and afterwards at Edinburgh until the age of 17, when he entered the warehouse of a Scottish merchant in Manchester. In 1868, after a brief migration to Glasgow, he returned to Manchester to assist in representing there the Dundee jute firm of Cox Brothers, soon rising to be head of the branch; and in 1880 he joined, as managing partner, the old-established firm of Henry Bannerman and Sons, which under his guidance entered upon an era of increased prosperity.

Macara was among the first to support the scheme for the Manchester Ship Canal, and the movement for the encouragement of cotton growing in other countries, especially the British Empire. During the war he was one of the first to declare the necessity of making cotton, from which high explosives are made, contraband of war, and took a leading part in securing that the compulsory Military Service Acts should be administered through local machinery rather than by the War Office direct. He was also actively interested in the National Lifeboat Institution, of which he was an honorary life governor.

Sir Charles, who was created a baronet in 1911, also received a number of foreign orders and decorations He had been a Fellow of the Royal Society of Arts since 1921.

A NEW ERA FOR FLAX.

So many of Britain's industries are based on textiles that I take the liberty of inviting attention to some new developments in the production of flax fibre, which may before long bring it into the world's markets in sufficient quantities to rival the production of cotton.

The world's acreage of flax in an average year, according to the U.S. Agricultural Year Book, was 15,870,000 acres; of which 4,447,012 acres were for fibre and 11,432,988 acres for seed only. The fact that a much greater acreage of flax is grown for seed than for fibre *and* seed is chiefly due to one of three reasons, *viz.*—shortage of water, lack of labour, and the objectionable nature of the process of retting (rotting) the straw. This process requires some skill and much indifference to foul odours. It consists in submerging the straw until fermentation loosens the fibre from the woody portions of the straw.

When flax is grown for seed only, the sowing is sparse, so that the plants may have room to branch out, but when the objective is fibre straw and seed, it is thickly planted, so that the plants may not have room to branch, except at their tops.

Flax grown for seed on the customary sowing of 30 pounds to the acre yields an average of 8 bushels of seed to the acre, worth $2.00 per bushel; most of the straw being burned to get rid of it. Flax grown for fibre *and seed* is usually planted

90 lbs. to the acre and yields 10 bushels of seed and two tons of straw ; comparative results being as follows :

Yield from seed flax per acre—8 bushels @ $2.00 per bu.		$16.00
Yield from fibre and seed—2 tons of straw @ $20 per ton ..	$40.00	
10 bushels of seed @ $2.00 per bushel	20.00	
		$60.00

The perfection of a new machine, which threshes and scutches unretted (or retted) flax in one operation with unskilled labour and gets double the yield of fibre hitherto obtained, supplemented by a new de-gumming process, simplifies the handling of flax as compared with that of other crops.

With this new method the farmer threshes and scutches his flax and sells the fibre and seed, and the buyer either processes the fibre himself at a central point or ships it to the spinning mill to be processed there ; thus eliminating the complicated and very objectionable labour of retting, and making it possible to produce a high quality of flax fibre at a cost much below any other fibre on the market.

Detailed costs in the United States and Canada are as follows :—

Per acre —Rental of land	$ 10.00
,, ,, Ploughing with tractor	2.50
,, ,, —Harrowing twice	1.00
,, ,, —Seeding (90 lbs.)	5.00
,, ,, Rolling	1.00
,, ,, —Machine pulling	4.00
(Hand pulling costs $11 to $16 per acre.)	
,, ,, —Shocking	0.50
,, ,, —Stacking	2.00
,, ,, —Average haul to mill	2.00
,, ,, —Interest on outlay	1.00
	$ 29.00
,, ,, —Average amount of straw, 4,000 pounds.	
,, ,, —Average yield of fibre with new method, 1,000 lbs. (Double that previously obtained.)	
,, ,, Cost of threshing and scutching with the new machine..	15.00
,, ,, — Cost of processing by new method, 1000 lbs. fibre ..	10.00
Total cost	$ 54.00
CREDIT —10 bushels of seed @ $2.00 per bushel	20.00
(The price of $2.00 per bushel for seed is for seed sold to linseed oil mills. Seed for re-seeding would be worth more.)	
—Net cost of 1,000 lbs. processed fibre .. .. .. or $3.40 per 100 lbs. (new method).	$ 34.00

The present cost of producing flax fibre in the United States and Canada is fifteen cents per pound.

An Oregon flax grower reports $4\frac{1}{2}$ tons of straw per acre from /J.W.S. seed on a 125 acre planting, but this is unusually large.

By the new process, sometimes called de-gumming, the flax is scutched green (unretted) and processed in a few minutes. No acids, alkalis or mineral oils are used. The figures of the world's flax acreage in 1925 are as follows :—

Canada	1,034,874	Lithuania	144,361
United States ..	2,489,800	Latvia	132,076
England and Wales ..	7,504	Estonia	75,365
Ulster	36,982	Finland	14,776
Free State	8,288	Russia	2,061,380
Sweden	5,700	Kenya	7,077
Netherlands	27,839	Morocco	40,924
Belgium	47,298	Algeria	648
France..	45,508	Tunis	5,588
Spain	3,857	Egypt	3,181
Italy	51,700	India	3,478,000
Austria	9,055	Japan	49,782
Czechslovakia ..	56,450	Chosen	3,386
Hungary	7,025	Chile	675
Yugoslavia	33,179	Uruguay	116,287
Bulgaria	634	Argentina	5,224,757
Rumania	40,021	Australia	452
Poland	242,006	New Zealand ..	8,685

There is no other crop so universally grown as flax. Most of the flax grown in the United States, Canada, India and the Argentine is grown for seed only.

Although the new methods are revolutionary in the art of producing fibres, they are all along the line of simplifying present methods, greatly reducing costs and getting uniformity. The farmer can dispose of his flax crop in the same way as his other crops, as soon as his straw is dried and scutched, and he is saved the exceedingly objectionable and expensive process of retting. All who have been approached in the United States and Canada have expressed themselves as eager to make a trial of it, if furnished with the right seed and shown a market for their unretted fibre.

As the fibre is only 28% of the weight of the straw, it costs much less to carry it to its destination.

The new de-gumming process is inexpensive and has no objectionable features, and can best be done at the spinning mill or a central distribution point. The commercial agents of the railroads are also exceedingly anxious to assist in every possible way to get this new freight for their roads.

In many parts of Europe there are buyers who purchase the straw and do the retting themselves, and this is part of the present plan in the United States, and is the only method by which uniformity in the retting of fibre can be obtained.

The lowest priced flax on the market is Russian, which brings 23 cents per pound, and the best is Belgian, which brings 33 cents per pound. It is conservative to claim that the new method flax will bring an average price between these two, which is 28 cents per pound. The margin between the cost of production (three-and-one-half cents per pound) and the selling price is so great that the costs can be multiplied and still be much below cotton, hemp or manilla, and being a superior fibre to any of these, flax will undoubtedly displace them for many uses.

GEORGE A. LOWRY.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 14.. Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Brewing, Institution of, at Charing Cross Station Hotel, Strand, W.C. 7.30 p.m. Annual General Meeting. Mr. James Stewart, "The Malting Barleys of 1928."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Major A. Jenkin, "Electric Trolley Omnibuses."

Engineers Society of, Burlington House, W. 6 p.m. 1)

Major E. Scott-Snell, "The Vacuum Power Oil Lamp." (2) Mr. Charles Scott-Snell, "Neu-Flame."

Geographical Society, at Lowther Lodge, Kensington Gore, S.W. 5 p.m. Colonel Sir Gerald Lenox-Conyngham, "The Cambridge Pendulums for Gravity Survey."

Heating and Ventilating Engineers, at the Borough Polytechnic, Southwark, S.E. 7.30 p.m. Mr. A. T. Henly, "Timber Drying and Seasoning."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Mr. A. Spittle, "Recent Developments in the Manufacture of Condenser Tubes."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture V—The Alps."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Brig.-General F. D. Hammond, "Some Transport Problems of the Empire."

TUESDAY, JANUARY 15..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Prof. Dr. R. Ruggles Gates, "Studies of Eskimos and Indians in the Canadian Arctic."

Architects, Royal Institute of British, 9, Conduit Street, W. 5.30 p.m. Mr. H. V. Lanchester, "The Development of South London."

Asiatic Society, 74, Grosvenor Street, W. 4.30 p.m. Mr. D. Harcourt Kitchin, "The Beja Races of the Eastern Sudan."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."

At the Technical College, Derby. 6.45 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as applied to Steam Generation."

Mechanical Engineers, Institution of, at the Royal Metal Exchange, Swansea. 6.30 p.m. Mr. J. W. Burr, "The Electrification of a Small Railway."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. R. Dowson, "Some Aspects of Steam Turbine Development and Application."

Philosophical Studies, British Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. Mr. Roger Fry, "Representation in Art."

Royal Empire Society, Northumberland Avenue, W.C.2. 8.30 p.m. Sir Burton Chadwick, M.P., "Seamen and the Empire."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. F. A. Freeth, "Critical Phenomena in Saturated Solutions."

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Discussion on the Presidential Address on "The National Income," to be opened by Prof. A. L. Bowley.

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. A. E. Sewell, "The Development of New Traffic by Transport Undertakings."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. J. H. Stirk, "Some Impressions of Transport in Canada."

University of London, at Bedford College for Women, Regent's Park, N.W. 10 a.m. Miss Johnson, "The Arthurian Legend in France."

WEDNESDAY, JANUARY 16..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. H. Dalrymple-Hay, "Merits and Demerits of Alternative Methods of Taking Water for modern Power Stations from Tidal Waters."

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr. T. W. Sampson, "The Electrical Engineer and Medical Science."

Fuel, Institute of, at Burlington House, W. 6 p.m. Messrs. Berg and Erich Vogt, "Continental Experience in Pulverised Fuel Practice."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Annual General Meeting. Sir Richard Gregory, Presidential Address, "Amateurs as Pioneers."

Microscopical Society, 20, Hanover Square, W. 8 p.m. Annual General Meeting. Presidential Address by Mr. Joseph E. Barnard, "Some Aspects of Ultra-Violet Microscopy."

North-End Coast Institution of Engineers and Ship builders, Bolbec Hall, Newcastle-on-Tyne. 7.15 p.m. Messrs. H. Caird and W. S. Paulin, "Steam Engine Machinery versus Diesel Machinery."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell "Mountains and their Origin: Lecture VI—The Alps (continued)."

United Service Institution, Whitehall, S.W. 3 p.m. Wing-Commander A. G. R. Garrod, "Auxiliary Air Force and University Air Squadrons."

University of London, at Bedford College for Women, Regent's Park, N.W. 3 p.m. Prof. Dr. Spurgeon, "Wordsworth and Coleridge."

THURSDAY, JANUARY 17..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. A. H. Dickins, W. E. Hugh and G. A. R Kon, "The Chemistry of the Three-carbon System Part XX. Cyclopentylideneacetone and Cyclopentylidenemethylethyl ketone." (2) Mr. H. D. K. Drew, "Non-existence of Isomerism among the Dialkyl Telluronium Dihalides." (3) Messrs. C. S Gibson and J. L. Simonsen, "Indian Turpentine from Pinus Longifolia Roxb. Part V: The Oxidation of d-Δ^3-carene with Beckmann's Chromic Acid Mixture."

Linnean Society, Burlington House, W. 5 p.m.

Mechanical Engineers, Institution of, at the Queens' Hotel, Birmingham. 6.30 p.m. Annual Meeting

At the Engineers Club, Manchester. 7.15 p.m. Dr F. G Ritchie, "Steam Storage."

At the Hotel Metropole, Leeds 7.30 p.m. Dr H W Swift, "Power Transmission by Belts. An Investigation of Fundamentals."

Metals, Institute of, at the Engineers' Club, Birmingham 7 p.m. Mr A. J. Dale, "Refractories for use in Metallurgical Furnaces."

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m.

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr Gordon Home, "Roman London."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. I. de Bruyn, "Rembrandt Etchings"

FRIDAY, JANUARY 18..Chemical Engineers, Institution of at the Institution of Civil Engineers, Great George Street, S.W. 6.30 p.m. Prof. John W. Cobb, "The Reactivities of Solid Carbon in Fuel Processes."

Dyers and Colourists, Society of, at Milton Hall, Manchester. 7.30 p.m. Dr. S. G. Barker, "The Standardisation of Fastness of Dyestuffs on Dyed Fabrics."

Electrical Development Association, British, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. C. H. Rayner, "Electric Heating and Cooking Developments."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. Foster Petree, "Notes on the Fitting and Operation of Michell Bearings."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Captain F. W. Cable, "Some Notes on the Collection of London Refuse."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. J. G. Weir, "Modern Feed-Water Circuits."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir William Bragg, "Further Progress in Crystal Analysis."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture VII—The Alps (continued)."

University of London, at Kings College, Strand, W.C. 5.30 p.m. The Rev. Principal John Oman, D.D., "The Study of Religion—Lecture II. Method."

SATURDAY, JANUARY 19..Geologists' Association, at the Museum of Practical Geology, Jermyn Street, S.W. 2.30 p.m. Dr. R. Crookall, "Coals, their Composition and Origin."

L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. D. Martin Roberts, "London through the Ages."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Monsieur E. Cammaerts, "Flemish and Belgian Art—The Portrait."

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All communications for the Society should be addressed to the Society, John Street Adelphi, W.C.2

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 21st, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture I.)

WEDNESDAY, JANUARY 23rd, at 8 p.m. (Ordinary Meeting.) SIR HENRY A. MIERS, D.Sc., LL.D., F.R.S., "Museums and Education." THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., will preside.

DR. MANN JUVENILE LECTURES.

The second of the two juvenile lectures annually given under the Dr. Mann Trust was delivered on the afternoon of Thursday, January 10th, by CAPTAIN SIR ARTHUR CLARKE, K.B.E., Elder Brother of Trinity House.

In this lecture Sir Arthur Clarke told the story of Lighthouses, which he described as "the street lamps of the sea - the street corner lamps that light the sailor at the beginning and end of his voyage, outward and homeward bound." He said that the cost of the upkeep of lighthouses, light-vessels, buoys and beacons round the coasts was about £1,000,000 per annum, and showed a number of lantern slides illustrating the different types of lighthouses which have existed at various times, from the Pharos of Alexandria, one of the seven wonders of the ancient world, and the Pharos of Dover, called Cæsar's tower and said to have been built by the Romans, down to the Eddystone Lighthouse of the present day. Sir Arthur then showed a number of slides illustrating the historical development of methods of illumination—beacon fires of wood and coal, candles, paraffin lanterns, incandescent petroleum, and finally electric light. He also referred to the numerous

modern devices now available for securing the automatic operation of the lights, and concluded with some remarks on directional wireless, which, he said, might be destined to the most potent factor of all for the protection of life and property at sea.

At the conclusion of the lecture a vote of thanks to Captain Sir Arthur Clarke was proposed by the Secretary, Mr. G. K. Menzies, and passed unanimously.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

WEDNESDAY, 12th DECEMBER, 1928.

SIR OLIVER J. LODGE, M.A., LL.D., D.Sc., F.R.S., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Mr. Blake knew more about electro-therapeutics than, at any rate, himself, and, he supposed, more than most of the audience did. He was very glad to take the Chair that evening at the request of the Royal Society of Arts, although, really, he had no right to do so when Sir Charles Parsons and Mr. Campbell Swinton were available.

The following paper was then read:—

APPLICATIONS OF ELECTRICITY TO MEDICAL PRACTICE.

By G. G. BLAKE, M.I.E.E., F.Inst.P.,

Hon. Radiographer in charge of X-Ray Department, Star and Garter Home for Disabled Sailors and Soldiers, Richmond.

In the first place I would like to say that the presence of Sir Oliver Lodge in the chair this evening makes this occasion one of the proudest moments of my life, and as far as the subject itself is concerned it would not be possible to have a more fitting Chairman. We all owe to him a great debt of gratitude for the part he took in sowing the seed from which has grown the tree of modern electro-therapeutic knowledge with its numerous branches. Since I received an invitation from your Society to deliver a lecture on "Applications of Electricity to Medical Practice," I have found some difficulty in deciding just how much could be included. The subject is so extensive that to deal with it adequately a whole series of lectures would be required. It is, therefore, my intention this evening to speak to you about some of those aspects of the subject which have come most closely within my own ken. The practice of electro-therapeutics is quite in its infancy, though the applications of electricity to medicine are now extending rapidly in every direction.

Prior to 1904 the medical profession made very little use of electricity; but at that date, at the invitation of the Dean of the Medical Faculty, Sir Oliver Lodge delivered a series of lectures at Birmingham University upon "Physics applied to Medicine."[1] In his opening lecture Sir Oliver used these words: "Electricity has not had a very good name hitherto in medicine; its application has been attempted, but apparently only with a modified success." Looking back over the 24 years which have since elapsed we can see what a great impetus Sir Oliver then gave to electro-therapeutics by his masterly series of lectures.

Since I commenced practice in 1905 (one year later) as one of the small band of pioneer radiographers and electro-therapeutists (the word radiologist had not then been coined) great developments have taken place. The lay radiographer in those days bridged the gap between the engineer and inventor on the one hand and the general practitioner on the other. Those of us who commenced practice, undertaking only to receive patients referred to us by qualified medical men, were readily supported In many instances we introduced the use of X-Rays and modern electrical treatments to the local doctors and hospitals, supplying the electrical knowledge which they lacked, while they on their side supplied the medical knowledge which we did not profess.

In 1905, beyond the X-Rays (which were at that time mainly a show thing of great interest to medical men, many of whom had never witnessed their application), electro-medical treatments were little known or used by local doctors. Some of the most progressive practitioners made use of Faradic currents, and interrupted constant currents, in the treatment of paralysis, relief of pain, etc. Electrically produced radiant heat was occasionally prescribed in cases of rheumatism, arthritis, neuritis, sciatica, lumbago, etc. They would also occasionally refer cases to us for the destruction of nævi, moles, etc., by electrolysis. Electrically heated cautery was also in use. Then again static electricity from influence or frictional machines was also occasionally employed by some of the general practitioners; within a radius of 10 miles from my treatment rooms I know of two such instances where the doctors had their own static machines. High-frequency currents were also just coming under the notice of the local medical men; brush discharge or effleuve was applied from powerful resonators (the treatment in a weaker form was not then to be found under a misnomer as "violet rays" at every hairdresser's establishment). At that date very few local installations were available, and patients had to be referred to cities and large towns for treatment. From high-frequency, owing mainly to the inventions and advances made in its application to radio telegraphy and telephony, diathermy treatment was evolved by Nagelschmidt in 1907, and for many years these currents were obtained either from hydrogen arc, or quenched spark generators; but

1. Archives of Rontgen Ray, Vol. VIII. 1904.

recently with the advent of thermionic valves, a new and more potent source of supply has become available. High frequency sparks[2] have been applied by surgeons since 1905 for fulguration or the destruction of morbid tissue. With the advent of diathermy currents[3] it was found that a scalpel or surgical knife, if suitably connected to a diathermy apparatus, would cut bloodlessly; this treatment has been called "cold cautery" (as the cutting blade remains practically cold) to distinguish it from cautery by means of a red-hot cautery needle. Recently it has been renamed "endothermy," a name which connects it in one's mind with diathermy, and completely distinguishes it from a form of cautery by means of carbon dioxide snow, which is much in use nowadays

Ultra-Violet Rays.

As long ago as 1893 Finsen, of Copenhagen, commenced to treat cases of lupus by the sun's rays and ultra violet light. A very powerful Finsen lamp was installed in the London Hospital in 1900, a gift of Her Majesty Queen Alexandra. At this time, although it was realised that the remarkable cures were due to ultra-violet radiations, the applications were locally applied.

In 1916 Simpson (an electrical engineer) devised a lamp which consisted of an arc between two Wolfram (an ore containing tungsten) electrodes. He opened a clinic in Victoria Street, where he successfully cured large numbers of cases of various diseases. Fortunately his achievements were boomed in the Press and made widely known; I well remember discussions which took place at the meetings of the Röntgen Society, and the interest that was shown. A new impetus was thereby given to the employment of ultra-violet rays as a curative agent, and Simpson's original arc was quickly followed by the Tungsten arc, the Mercury vapour lamp, and other forms of ultra-violet apparatus at present in use for actino-therapy (artificial sunlight treatment). Since whole body irradiation has been in vogue, I have seen some truly wonderful cures in my own experience, of children suffering from tuberculosis, rickets, anæmia, etc. I consider the results so startling that if only the beneficial effects of occasional general treatment by ultra-violet rays could be made more widely known, I believe in a few years every home where an electricity supply is available would have a lamp installed and artificial sunlight baths would become as customary as ordinary bathing. The place for irradiation by ultra-violet rays is not a cold bathroom as I have seen suggested,

2 See Tousey's description of an electrode for application of H.F. sparks for their destructive effect, before the American Electro-therapeutic Association in 1905; also Keating Hart's method employing H.F. sparks for cancer (Archives d'Electricité Medicale, August 10th, 1907).

3. During the War the lecturer suggested and worked out a method of sterilizing fragments of shrapnel, while still embedded in the patient, by means of eddy currents, the principle being similar to that employed in the modern high-frequency induction furnace See "The production of Diathermy Currents," by G. G. Blake, Journal of the Wireless Society of London, Vol. II, November, 1921.

but a warm sitting-room, or a bedroom, where the treatment can be had in warmth and comfort before retiring. With reasonable care the treatment is a very harmless one; its administration only requires a little common sense. An over exposure will produce an erythema (inflammation of the skin accompanied by soreness) similar to the familiar sunburn so prevalent at the seaside at holiday time. It is absolutely essential to protect the eyes from the rays; the usual method is to wear dark glasses tested for their opacity to the ultra-violet rays. It is also necessary to screen the back of the head and neck from the rays to avoid sunstroke; this can, of course, be done by wearing a suitable head covering. If not over indulged in the treatments produce a feeling of exhilaration and wellbeing which it is difficult to describe; I have often experienced it myself. On the other hand, a too frequent exposure to the rays will tend to produce the reverse effect, and cause a feeling of lassitude. This should be taken as nature's warning to abstain for a few weeks, after which the treatments can be resumed.

THE LOCAL APPLICATION OF ULTRA-VIOLET RADIATIONS.

As already mentioned, Finsen's earliest applications of ultra-violet rays were for local treatment; he concentrated the rays from a powerful arc lamp by means of a system of water-cooled quartz lenses upon the diseased area. The curative effects were accelerated by pressing the lenses against the part under treatment to render it anæmic.

It was soon shown by Bang[4] that the substitution of water-cooled iron electrodes for carbons greatly increased the yield of ultra-violet, and these water-cooled arcs could be run much more economically as regards current consumption.

In Germany at about this time[5] Görl introduced a new type of lamp for local treatment; instead of using an arc he employed a spark discharge from a condenser between spherical iron electrodes.

In 1906 Prof. Kromeyer, of Berlin,[6] devised a mercury vapour lamp made of quartz (very similar lamps made of glass had already been devised by Cooper Hewitt for purposes of illumination). These new quartz lamps were specially suited for therapeutic purposes as they permitted the short ultra-violet rays to pass which glass would have absorbed.

In 1924, while preparing a lecture on Photophony[7] for the Radio Society of Great Britain, I received the speech-laden beam of light by aid of a Parabolic mirror; the light thus collected was focussed upon one end (optically polished)

4. Medical Electricity and Röntgen Rays, by S. Tousey. Published by W. B. Saunders and Co.

5. Medical Electricity and Röntgen Rays, by S. Tousey. Published by W. B. Saunders and Co.

6. Münch. Med. Woch., 1906. No. 10. P. 577.

7. Experimental Wireless and Wireless Engineer, Vol. II, June, 1925. Pp. 561-573.

of a curved glass rod; the latter conveyed it longitudinally to its far end (also optically polished), whence the light was projected on to a selenium cell. The rod not only conveyed the light round the bend, but incidentally acted as an efficient heat filter and kept the cell cool.[8]

[This was illustrated by a lantern slide]

Finding this scheme quite successful, the idea occurred to me that similar use might be made of solid quartz rods for the conveyance of ultra-violet radiations round bends, to otherwise inaccessible parts of the body, and I took out a provisional patent to cover this idea in March, 1925[9], but foolishly I did nothing further with it. Recently I have made enquiries and I find that Zilz and Seidel were already using quartz applicators in Germany.

[At this point, by means of a specially devised apparatus[10] the lecturer demonstrated the simultaneous production of many widely differing wave-lengths in the ether, viz., ultra-violet, the visible spectrum, heat radiations, and Hertzian waves, as employed for wireless, thus showing that all these apparently disconnected phenomena are in reality vibrations in the ether differing only in their frequencies.

A demonstration was also given of the transmission of ultra-violet rays from end to end of a semi circular rod of quartz.

A photograph of a still life group was shown as taken by the visible light from a tungsten arc. Other photographs of the same group were shown taken in the dark by ultra-violet rays[11] only, the visible rays being screened out by a filter of special glass made by Messrs. Chance Bros., of Birmingham.]

The Measurement of Ultra-Violet Rays for Therapeutic Purposes.

Several methods have been suggested:-

(1) By noting the changes of tint of pastilles coloured with methyl blue (or other chemical affected by the Rays) when used in a similar manner to that in which Sabouraud pastilles are employed for measuring doses of X-Rays.

(2) Messrs. H. D. Griffith and J. S. Taylor have suggested the use of a photo-electric cell in conjunction with an electroscope.[12]

(3) A couple of years ago I suggested that a photo-electric cell might be connected to the grid of a triode thermionic valve, and used to control the plate current. The readings of a milliampere meter in the plate circuit would give us a measurement of the amount of ionization produced within the cell by the ultra-violet radiations.

8. Patent application, 6091/25.

9. Patent application, 5801/25

10. Experimental Wireless and Wireless Engineer, June, 1925. G. G. Blake, "Communication on Wave-lengths other than those in general use." Lecture before the Radio Society of Great Britain, at I.E.E., April 22nd, 1925.

11. Experimental Wireless and the Wireless Engineer, June, 1925. G. G. Blake, "Communications on Wave-lengths other than those in general use." Lecture before the Radio Society of Great Britain at the I.E.E., April 22nd, 1925.

12. H. D. Griffiths and J. S. Taylor, "The Cadmium Photo-electric Cell for measuring Ultra-Violet Radiation," Modern Sunlight, Vol. I, May, 1926, p. 32.

THE DETECTION OF RINGWORM BY ULTRA-VIOLET RAYS.

One of the latest uses we are making of ultra-violet rays is to enable us to detect the presence of tinea (ringworm), by noting its characteristic fluorescence. These examinations are carried out in the dark and all the visible rays are excluded by means of "Chance glass" or other suitable filters.

[The characteristic fluorescence of various substances by ultra-violet irradiation was then demonstrated].

I have often been asked which source of ultra violet is the most suitable for therapeutic purposes, the tungsten arc, the flame arc, or the quartz mercury vapour lamp?

Each lamp has its own merits and disadvantages. The tungsten arc is probably the richest source of those wave-lengths which are required, i.e., those between 2,360 and 4,000 Angström units, which penetrate to the deep epidermic cells and are absorbed.[13]

In common with all other unenclosed arc lamps, it has also a great advantage in that there is no window between the patient and the source of radiation, so that all the wave-lengths that are able to penetrate the intervening air reach the skin; the lamp is also just as efficient when old as when new. Its drawbacks are the necessity to keep the tungsten electrodes clean and free of tungsten oxide and the fact that as the arc burns it emits a vapour of tungsten oxide, but as this vapour has been recommended for inhalation for certain diseases of the chest, it is apparently harmless.

The flame arc, though not nearly so rich in the shorter wave-lengths, gives possibly a nearer resemblance to the sun's rays, but to be effective it requires far more current and much longer exposures.

The mercury vapour lamp needs far less attention than an unenclosed arc. When new, it is nearly, if not quite, equal to a tungsten arc in the emission of the shorter wave-lengths, but it has the great disadvantage that the quartz enclosing the mercury vapour gradually becomes in use less transparent to the shorter wave-lengths. At first this can be compensated for by increasing the length of the exposures, but increased use more rapidly ages the tube, and after a life of between 1,000 and 1,200 hours it is necessary to employ a new lamp; by this time it will have lost about 40% of its efficiency. This is not due simply to a gradual diminution of the brilliance of the whole spectrum. As the lamp ages the shorter wave-lengths towards the lower end of the spectrum are filtered right out to an increasing extent.

Taking all these points into consideration, I personally prefer the tungsten arc. Until recently the latter had one serious disadvantage, i.e., though it worked admirably from a direct current supply, it was impossible to strike an arc between tungsten electrodes when the supply was A.C. or even rectified A.C. In order to try and overcome this difficulty carbon electrodes cored

13. "Ultra Violet Rays in the Treatment and Cure of Disease," by Percy Hall. Published by Wm. Heinemann, Ltd.

with tungsten were employed, but in my opinion they are not nearly so efficient as pure tungsten. Recently the Medical Supply Association (London) has placed a special rectifier on the market[14] by means of which the difficulty is entirely overcome, and it is now possible to use a tungsten arc from either A.C. or D.C. supply.

[A tungsten arc, kindly lent by the Medical Supply Association, Gray's Inn Road, was then shown working from an alternating current supply. It was also demonstrated that in the absence of this apparatus a tungsten arc cannot be struck or maintained on an A.C. or a rectified A.C. supply].

IONIC MEDICATION.

I make no serious attempt in this paper to trace the various types of treatment to their earliest applications. According to James Morton,[15] the first claim of the transportation of medicines into the body by electricity was made by Pirvati, of Venice, in 1747, but according to this author small credence is to be placed on this claim. He attributes the first credible researches to G. Weidemann in 1853; little was heard, however, of this form of medication after this for many years. In 1889 a paper by Newman Lawrence and A Harris was read before the Society of Arts on their "Cataphoric Method of Medication," and in 1890 Thomas A. Edison read a paper at the International Congress held in Berlin. He claimed that he had been able to reduce the size of enlarged joints in a gouty subject by conveying lithium into the body by aid of an electric current. He placed one hand of the patient in a dish of saline solution, and the other hand in a solution of lithium chloride The two solutions were then connected to the poles of a C.C. battery making the lithium positive, and the saline solution negative After treatment he showed the presence of lithium in the urine These experiments were conclusive, and since that date much work has been done on the subject. This form of treatment is now freely prescribed by the medical profession; it is in fact one of the most commonly used forms of electrical treatment.

Newman Lawrence and Harris were probably the first to employ the term "Cataphoric medication." Since then many other names have been employed, such as, "Cataphoresis," "electrical osmosis," "ionic medication," and "ionization." These terms are frequently misused. "Cataphoresis or electrical osmosis" is a phenomenon which accompanies ionic medication, but is really a different process; it indicates the actual transfer of liquids through the pores of the skin under the action of an applied electro-motive force. Personally, I believe it may be due to alteration of surface tension and electro-capillary action through the pores of the skin (the same phenomenon that is made use of in the Lippmann capillary voltmeter).

14. British Patent No. 279,680/27.

15. See "Cataphoresis as applied in Medical Surgery and Dentistry," by James Morton Published by Swan, Sonnenchein & Co., in 1898.

Ionization implies the transference of "ions" under the application of an electro-motive force, but does not indicate the actual transfer of the whole solution.

The two terms are, I am afraid, often used indiscriminately in medical prescriptions. It is also an understood thing that the electro-therapeutist shall discern between anions and cations (positive and negative ions) and employ the correct polarity when treating patients by ionization.

One could easily fill an evening enumerating the various ways in which electricity is now used in medicine. There is the Leduc current (a type of interrupted constant current in which the duration of the make and break are under accurate control, and in which the relationship between them can be altered at will). There is electrically produced vibratory massage. Powerful magnets are employed for the removal of fragments of steel or iron from the eye. I have such a magnet which I have on occasion used at the local hospital. Magnets are also used for the detection and location of fragments of shrapnel, etc., by noting the quivering of the tissues when a magnet fed by alternating currents of low periodicity is held in the vicinity of the foreign body, of which the depth and position can thus be judged.

Another instrument for the detection of foreign bodies is the electric probe, which, in conjunction with a telephone, makes a sound when it comes into contact with the foreign body.

Electric lights are employed in numerous instruments, for the testing of sight, transillumination, etc. One has frequently to transilluminate the antrum when X-raying the teeth to detect the presence or otherwise of pus. There are various endoscopes employed for internal examinations, the examination of the bladder, etc. Operating theatres are now illuminated in such a manner that no shadows are present to impede the surgeon during operation, this desirable result being achieved by means of mirrors. Then there is the Bergonié treatment for the heart, and for the reduction of obesity. The Cambridge Scientific Instrument Company has devised an instrument called the electro-cardiograph,* by means of which it is possible to demonstrate and record the human heart beats, for which purpose they employ an Einthoven string galvanometer ; they also make an apparatus called a phono-cardiograph, which records the volume and power of the sound, also its pitch and tone. This instrument enables us to settle the exact position of any sound or murmur in respect to the main events of the cycle of heart movements.

Electricity has been employed for measuring the time taken when converting thought into action.[16] I devised an apparatus for this purpose as far back as 1909.

*Commercial oscillographs have recently been employed with success for electro-cardiography by P. Fabre. *Comptes Rendus* 187, pp. 257-258, July 23rd, 1928. Their introduction into this branch of electro-medical investigation is likely to become very general, owing to their comparatively low cost of manufacture.

16. "Measuring the Time Taken in Conversion of Thought into Action," G. G. Blake. "Knowledge," Vol. VI, pages 14 and 15. January, 1909.

METHOD OF MEASURING AND RECORDING THE HUMAN EMOTIONS WITH A THERMIONIC REFLEXOMETER.

In 1900 Veraguth, of Zurich, was the first to discover that a change of electrical resistance takes place in human beings as a result of emotional stimuli.[17] This action or rather reaction is known to psychologists as the psycho-galvanic reflex.

When lecturing for the Institution of Electrical Engineers at Derby in March this year, I borrowed the apparatus usually employed for this purpose, i.e., a specially constructed Wheatstone bridge and sensitive galvanometer. The apparatus performed its functions quite well, but, as I found it most difficult to keep the bridge balanced by aid of the five necessary adjustment knobs while the resistance of the patient was ever in a state of change owing to his uncontrollable emotions, I have since devised a more simple method which requires only one variable adjustment. In place of a Wheatstone bridge, a thermionic valve and circuits are employed.[18]

I am using this new arrangement for my demonstration this evening.

As I hope to show you, any sudden emotion will (after a pause of approximately two seconds) cause a sudden deflection of the moving coil of the galvanometer, due to an increase of conductivity. The amplitude of this deflection varies according to the type and intensity of the emotion and other conditions.

Response can be obtained by the reaction of the subject to a sudden noise, an electrical or other shock, the prick of a pin, a sudden threat of violence, and even to quietly spoken words which conjure up emotion due to sad or joyous memories, etc.

With this apparatus it is possible to measure the change of resistance produced by any emotion.

I have brought an amplifier, and I hope this evening not only to make this resistance change visible to you by aid of a mirror galvanometer, but (for the first time in public I believe) to render it audible to you as well.

[The foregoing applications of a thermionic reflexometer were then demonstrated].

Prideaux[19] has demonstrated the difference between the reactions of hystericals and of patients suffering from anxiety-neurosis, and Waller[17] tested a number of people and showed that the only portions of the anatomy of an ordinary individual which responded were the hands and feet. In the cases of certain spiritualistic mediums whom he tested, he discovered that they responded anywhere up either arm or leg, in addition to showing the

17. Das Psychogalvanische Reflexphenomen (Berlin 1900). See also "The Electrical Expression of Human Emotion," by A. D. Waller. Proc. Royal Institution, Vol. XXIII, 1921, pp. 283-293.

18. "The Measurement of Emotions by means of a Thermionic Reflexometer," by G. G. Blake. Electrical Review, Vol. CIII, No. 2661, pp. 882-884, Nov. 23, '28. (This paper gives details with diagrams and curves).

19. "Some Applications of the Psycho-galvanic Phenomenon," by T. H. Pear. "Discovery," Vol. V. Pages 116-119, July, 1924.

usual hand and foot responses. Of course this does not in any way prove the truth of spiritualistic beliefs, but it certainly indicates the abnormal sensibility of certain mediums who underwent the test, and it would appear according to this investigator to provide a method of distinguishing people with genuine mediumistic powers from those who can only make claim to possess them.

My own investigations have been so far mainly concerned with an endeavour to establish some standard against which all psycho-galvanic reflexes can be gauged. For this purpose I apply a series of known and gradually increasing voltages to any part of the subject other than that included in the thermionic valve circuit (I usually apply these shocks to the free hand of the subject). The resistance change due to each suddenly applied voltage stimulus is then

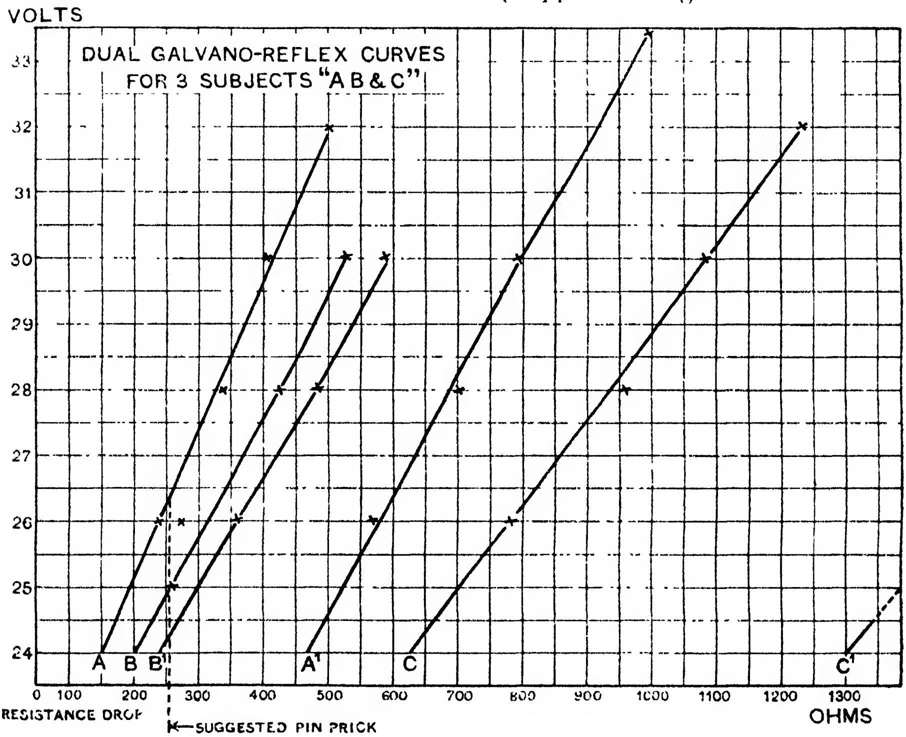


Fig. 1.

noted and curves are plotted similar to those shown at A, B, and C (Fig. 1). A', B', and C' are also curves of the same three subjects, and are plotted in exactly similar manner, except that whereas the shocks for curves A, B, and C were applied by an operator, those for A', B' and C' are self-inflicted by the subject, who in this latter case himself depressed the switch. By reference to curve A it will be seen that the mere suggestion to the subject of a pin prick (not actually applied) produced a galvano-reflex, which was equivalent to an actually applied shock of 26.4 volts. I think we can assume

therefore an equal loss of nervous energy in either case. In every case so far observed the self-inflicted shocks produced a much greater effect than did a shock at the same voltage applied by someone else. Another interesting result at once observed by a study of these curves is the great difference in the distance apart of the dual curves for various subjects. Possibly a study of these dual curves may throw light upon the relative ability of subjects to receive impressions.

After a series of emotional stimuli, the reflexes begin to tire. When this stage is reached it is useless to continue the sitting. I have no doubt, however, that an investigation of this effect would be fruitful in estimating the rapidity of nervous exhaustion. A series of stimuli (all of one voltage) could be applied to a subject at equally recurring intervals of time.

Much work requires to be done on these and similar lines and a great number of curves[20] need to be made with every variety of subject; at present I can do no more than indicate a few possible applications.

Galvano-reflex curves of neurotic patients undergoing electrical or other forms of treatment, plotted before and after treatment, might, I think, provide us with a method of estimating the improvement in their nervous conditions. It would be interesting and possibly useful to investigate the effects produced on galvano-reflexes by various drugs, such as aspirin, alcohol, etc. I am also inclined to think that a careful study of a large number of curves of patients suffering from various diseases might be of value in the study of diseases and might possibly aid diagnosis.

There is one other interesting experiment which I should like to show to you. (This is an entirely new experiment never before demonstrated.)

Two subjects can be placed one in each arm of the "thermionic reflexometer."[21] If I prick one of them with a pin, the galvanometer will deflect it to the left, and if I prick the other subject, a right hand deflection takes place. If I stimulate them both suddenly by a sudden noise, a kind of emotional "tug-of-war" will occur and one or other of them will win and bring the deflection over to his side of the scale.

[An emotional "tug-of-war" was then demonstrated, and the effect was rendered both audible and visible.]

Numerous experiments have been performed on the growth and development of animals and plants; in fact, there are one hundred and one other electrical applications which it would occupy too much time to describe.

Before showing you any further experiments, a short space must be devoted to X-rays, as they most certainly come well within the scope of this lecture

20. As that portion of the galvano-reflex curve with which we are working at present forms practically a straight line, and the dual curves for each subject are found to run parallel with the A curves, it may only be necessary to apply shocks at one fixed voltage to all subjects, and then to compare the resistance drops resulting from (A) the shocks applied by an operator with (B) the fall in resistance due to self-inflicted shocks of the same value

21. I am indebted to the Medical Supply Association for the loan of some of the apparatus we are using this evening

There is no need for me to remind you that the medical profession is indebted to a very large extent to the late Sir William Crookes, whose early researches led to the discovery of X-rays by Prof. Röntgen in 1895. The discovery, which the latter communicated to the Physico-Medical Society of Würzburg, Bavaria, in the November of that year was to the effect that some crystals of barium platino-cyanide were placed near by a vacuum tube, and that although the latter was completely covered with black paper, the crystals fluoresced under the influence of some invisible radiations. He also showed that fluorescence could still be produced even when these radiations were intercepted by such solid bodies as books, sheets of aluminium, etc

In March, 1896, only a few months after Röntgen's discovery[22] Mr. A. A Campbell Swinton read a paper which I believe to be the first on X-Rays delivered in this country; it was entitled "Röntgen's Photography of the Invisible," and was given before this Society under the chairmanship of the late Prof. Dewar (afterwards Sir James Dewar). Several X-ray photographs were actually taken during the lecture and shown to the audience; these were certainly some of the very earliest radiographs taken in this country

At its conclusion Sir James characterised it as "an interesting and almost epoch-making paper," and this it has certainly proved to have been.

On that occasion, Mr Campbell Swinton (who, I believe, has been Chairman of your Council four times), after pointing out that ordinary photographic plates as then used were not necessarily the most suitable for X-ray photography, said, "It appears to me that the sensitiveness of photographic plates to these rays might very probably be very largely increased by treating them with fluorescent substances or even by arranging a fluorescent screen to be in contact with the film during the exposure."

His suggestion has long since become an accomplished fact; I doubt if there is a radiographer or a radiologist anywhere who does not employ intensifying screens He also made the following prediction:—"There seems every prospect by its (X-rays) means of being able to determine the extent of calcareous deposits in the internal organs of the body, malformations and diseases of the bone, etc." . . . "It may in time be possible to photograph or actually see the internal organs in operation," etc.

All these predictions have been abundantly fulfilled and it must not be overlooked that modern radiology owes its origin to those suggestions.

In 1896 Mr. Campbell Swinton modified Röntgen's design of an X-ray tube and improved the definition of X-ray photographs by the insertion of a sheet of platinum set at an oblique angle to the path of the cathode stream.

As far back as 1874, in order to display the heating effects of the cathode stream, Crookes had by the employment of a hollowed-out cathode actually brought them to a focus upon a thin sheet of platinum. This tube must have

22. Journal of the Royal Society of Arts, Vol. XLIV, March 6th, 1896.

been a powerful source of X-rays, but, unfortunately, being invisible and unexpected, they remained unnoticed.

In 1896 Professor H. Jackson constructed a tube very similar in design, but this time with special reference to the production of X-rays. It was a combination of those employed by Crookes and Swinton. He brought the cathode stream to a focus by means of a concave cathode, the anode on to which they were focussed being set at an angle of 45°. X-rays from this tube being generated from a point source, sharp shadows resulted, making it possible for the first time to obtain really clear and useful radiographs. Kaye has since shown that the output of a tube is almost independent of the angle at which the anticathode is set.[23]

Independently and during the same year Campbell Swinton and Elihu Thomson designed double cathode tubes for alternating currents.[24] Since this date many types of tube have been designed and placed on the market. Until 1913 partially exhausted gas-filled tubes held complete sway, but following the advent of the thermionic valve, invented by Professor Fleming in 1904,[25] and a large amount of research work carried out mainly at the Cavendish Laboratories at Cambridge,[26] Professor W. D. Coolidge, of Iowa, U.S.A., designed a tube[27] having a hot spiral filament as its cathode. This tube was very completely exhausted. Its outstanding feature from the radiographic point of view was that the number of electrons projected from the cathode depended upon the temperature of the latter. This tube has since come into very general use; it has many points in its favour, although it is at least four times as expensive as a good gas-filled tube

In the hands of a practised radiographer the latter will yield equally good if not better work (I speak, of course, of the radiography of patients; it will not, I believe, compete with the Coolidge tube in the radiography of metals).

The Coolidge tube is unquestionably much less difficult to handle, and can be used by rule of thumb methods.

In 1924 another very important innovation in X-ray tube construction was achieved—I refer to the introduction of the Philips Metalix tube.[28] Its

23. See Proc Röntgen Society, 1909, and "X-Rays," by G. W. C. Kaye, D.Sc. Longmans Green & Co.

24. "Electricity in the Service of Man," by R. Mullineux Walmsley. Cassell & Co.

25. Proc, Royal Society, London. Vol LXXIV, page 476, 1905. Also "History of Radio Telegraphy and Telephony," by G. G. Blake. Chapman & Hall (for Edison effect and the Wehnelt hot cathode).

26. "Some Aspects of Radiology," by G. W. C. Kaye. Rontgen Journal, Vol. XVI, April, 1920.

27. Paper by W. D. Coolidge. Physical Review, Vol. II, Series II, 1913. Page 409. Also "The Measurements of Radiation from the Coolidge and other X-Ray Tubes in Clinical Use" By Sidney Russ Röntgen Journal, Vol. XI, page 42, April, 1915.

28. Fortschritte auf dem Gebiete der Röntgenstrahlen (Kongressheft Innsbruck, 1924). Also "New Metalix Tubes for Radiography and Therapeutics," by A. W. Bouwers. (Physicist of Philips Lamp Works). British Journal of Radiology (Röntgen Society Section), page 139-143, April, 1927.

construction incorporates several new and very important features, which, in my opinion, are likely to earn for it a pre-eminence in the radiographical world.

Firstly, there is the method employed for bringing the electron stream to a focus. In lieu of a concave cathode or spirally wound filament, use is made of an electrostatic field similar in some respects to that employed in a cathode ray oscilloscope. The cathode stream passes through a negatively charged diaphragm which repels the electrons to its centre, and in this way brings them to focus upon the anode.

The development of thermionic valves for radio-telegraphy has led to much research work on the sealing of glass to metal, also methods for making metal impervious to gas molecules, so that when a metal tube is once exhausted it will retain its condition of vacuum. The Metalix tube, as its name implies, is made of metal and has a glass window sealed into one end. As the latter is the only part of the tube transparent to the X-rays, the need for heavy and cumbersome protection boxes, with which all other forms of X-ray tube have to be surrounded, is entirely dispensed with. The anode of this tube is also of unusual construction. It is set parallel with the cathode, and the cathode stream impinges against the sides of a conical hole in its centre. In this way a larger surface of metal is subjected to bombardment than would be the case were the surface flat, and as the major part of the spluttering accompanying the electronic bombardment takes place within the conical cavity the walls of the X-ray tube are shielded.

In addition to the primary function of the charged diaphragm already described, the latter performs another extremely useful purpose. It is well known that the life of the filament of an X-ray tube is considerably shortened owing to its bombardment by positive ions, which travel in the reverse direction to the cathode stream. The charged diaphragm must also act as a screen against this effect.

I am hoping that X-ray tube manufacturers will be able to borrow one more idea from the radio engineers, and that they will soon supply us with X-ray tubes fitted with dull emission filaments. Lack of time makes it quite impossible this evening to touch on X-ray coils, interrupters (electrolytic, arc, or mechanical), high tension transformers, screens fluorescent, or intensifying, the Potter-Bucky diaphragm,[29] the radiography of the gall-bladder by aid of iodeikon, etc.

The first radiographs were taken by Röntgen in 1895, when he obtained shadows of metal objects inside a wooden box, and also outlines of the bones of the hand. Even at that date the great possibilities which X-rays offered to surgery were noted by him. These new rays naturally made a great appeal to the imagination of hundreds of scientifically-minded men, both lay and medical, and following the introduction of the Jackson focus tube, X-rays

29. For description see Wilsey. The American Journal of Röntgenology, January 1922.

A. Barium Meal Radiograph of stomach. Arrow indicates gastric ulcer.

B. Same Patient 15 minutes later. Note Barium still retained at point of ulceration. A quantity of the meal is now in small intestine.

C. Same Patient 24 hours after intake of meal. Showing sagging of transverse colon with sharp kink at hepatic flexure.

D. A Patient suffering from a malignant growth which almost completely obstructs the passage of the meal.

E. A tooth in right antrum.

F. A fractured clavicle.

G. Diverticulum of oesophagus.

H.—Lateral view of dorsal vertebrae.

Dental Radiographs.

I. Unerupted and misplaced canines.

J. Four lower incisors. Note focal abscesses.

K. Plastic radiograph of needle in hand.

FIG. 2.

soon found a recognised place in surgery. Examples of radiographs from my own practice are given in Fig. 2. The plastic radiograph " K " is made in a special manner and is the result of a combination between a positive and a negative picture.

STEREOSCOPIC RADIOGRAPHY AND LOCALIZATION.

In 1896 Elihu Thomson pointed out that stereoscopic radiography could be achieved if the X-ray tube was displaced a distance of about 2½in. for the second exposure, and that such radiographs should be of great value to surgeons in the location of foreign bodies.

One of the first to make use of his suggestion in this country was the late Sir James Mackenzie Davidson, who not only worked out a practical method of making such radiographs and of viewing them afterwards by means of a Wheatstone stereoscope, but by applying the principles of triangulation (suggested by stereoscopy) was the first to devise a method in 1898[30] of measuring the exact depth and location of embedded foreign bodies. This is now well known as the Mackenzie Davidson cross-thread method of localisation.

Since this date many other X-ray workers have made use of very similar methods of geometric localization.[31] While most of these methods are quite satisfactory, all of them—with the exception of the very useful " Parallax " screening method—require careful preliminary notes and measurements, as to tube distances, displacements, etc. Again, they require specially designed tube-holders, fitted with tube height and displacement scales and the like. After the outbreak of the War, I was called upon to do a large amount of portable radiography at the various hospitals* to which I had been appointed radiographer. Massive tube stands were out of the question, and when asked by the surgeons to report on the localisation of fragments of shrapnel, etc., I soon found myself severely handicapped. It being impracticable to employ heavy calebrated stands for this portable work, I devised a method[32] by means of which localization can be carried out without any preliminary measurements. Any simple protective stand can be employed and no notes or measurements of the tube displacements have to be taken. Only one photographic plate is required and on this plate two exposures are made without disturbing the patient. All the necessary measurements, tube displacement, height of tube, and displacement of the shadow of the foreign body are self recorded (photographically).

The radiograph thus obtained provides a permanent record of the case from which at any time the depth of the foreign body or bodies can be ascertained either graphically by triangulation, or by the equation $X = \frac{dh}{d + L}$

where X = the depth of the foreign body

d = the displacement of its shadow on the X-ray plate,

h = the height of the tube from the plate when the exposures were made,

L = the distance that the tube was displaced between the two exposures.

30. Archives of Röntgen Ray, May, 1898. Also Proc. Royal Institution, Vol. XXI, Part III, No. 110, April, 1918, pp. 662-668.

31. For further information on the various best known methods refer to " X-Ray Observations for Foreign Bodies and their Localization," by Harold C. Gage. Published by Wm. Heinemann, 1919.

*Seven Red Cross and four civilian Hospitals.

32. Journal of Röntgen Society, Vol. XI, No. 42, January, 1915, and Vol. XII, No. 46. Also, Archives of Radiology and Electro-therapy, July, 1915. Also, Knowledge, Vol. XXXVIII, November, 1915.

Before the radiographic exposures are made a couple of small adhesive metallic plasters (say in the shape of a square and a triangle) are placed on the skin. These are arranged so as to be in contact with the plate to ensure that each of them will only cast one shadow. When the radiographer's report is handed to the surgeon in charge of the case, the latter is given a tracing on a flat sheet of celluloid upon which the positions of these two adhesive markers are indicated, together with the exact position of any foreign body or bodies relative thereto. It is then only necessary for the surgeon to move the limb or other part of the patient into the one and only position which will enable him to place the tracing in exact coincidence with the markers on the patient's skin. When this has been achieved, he knows that he has placed the patient in exactly the same position as that in which he was when the radiographic exposures were made. I have found this scheme of particular advantage as in nine cases out of ten the surgeon is not present when the localization is being made. He has now only to make incisions at the positions indicated on the tracing in order to reach the foreign bodies at the depths which he is also given.

I have further extended this method to the exact localisation of foreign bodies in the eye.[33] In this case also only one plate is employed, on which all the measurements are self-registered and recorded and the exact position of the F.B. is afterwards ascertained in three planes.

[Slides were then shown illustrating three examples of foreign bodies localized by the above method, viz :- a needle in a hand, an airgun bullet within an eye; and a fragment of shrapnel in an eye. Examples illustrating the use of radiographs by Veterinary Surgeons were also shown[33]].

THE THERAPEUTIC APPLICATION OF X-RAYS.

X-rays were probably first brought into use as a therapeutic agent in 1896. The question of priority in their therapeutic application has been a much disputed one.[34]

In France Dr. Despeignes[35] reported the application of X-rays to a case of cancer of the stomach in 1896.

In 1897 Freund reported the X-ray treatment of a large hairy nævus[36] and the next year Freund and Schiff reported six similar cases successfully treated.[37]

33. Archives of Radiology and Electro-therapy, July, 1915. (When this paper was written one preliminary measurement was necessary, i.e., the distance from the centre of the bridge of the nose to the X Ray plate. This can be dispensed with by placing a small pellet of lead in that region before the exposures are made, and ascertaining its distance from the plate after development, from the displacement of its shadows by triangulation).

34. See "The Rontgen Rays in Therapeutics and Diagnosis," by Pusey & Caldwell. Published by W. B. Saunders & Co.

35. "La Semaine Médicale," July 29th, 1896. Vol. XVI, p. CXLVI.

36. Wiener Medizinische Wochenschrift, March 6th, 1897. Vol. XLVII, p. 428.

37. Wein. med. Wochens, 1898. Vol. XLVIII, p. 1058.

Another of the earliest authentic reports of X-ray treatment which I have been able to find is a report by Ravillet in 1899 of benefit in a case of tuberculous laryngitis.[38]

Out of a large number of reports which have appeared in various medical journals, it is very difficult to discover who was the first to apply X-rays to lupus. I find that a case was treated by Schiff and Freund in Germany in 1898.[39] A case was referred to me for treatment by Dr. Gardiner in 1905; (this was illustrated by lantern slides as seen before and after treatment). I believe Kümmel[40] reported a cure during 1897. In the United Kingdom, Hall Edwards[41] treated a case of lupus in 1900. The treatment of tinea (ringworm) was suggested by Freund in 1897. One application of X-rays, followed by removal of the hairs after an interval of from 15 to 21 days completes the cure, and in my experience of the treatment of hundreds of such cases during the last 22 years, I have never come across a single case in which there has not been perfect regrowth of hair Idiosyncrasies are, however, stated to exist.

The earliest case of the treatment of cutaneous carcinoma by X-rays was (according to Pusey) a rodent ulcer treated by Stenbeck[42] of Stockholm, and demonstrated by him in December, 1899

The foregoing are undoubtedly some of the very earliest applications of X-rays for their curative influence, and I do not intend to extend the list any further this evening. Had there been time I should have liked to have shown you how the technique has developed since these first therapeutic applications, until to-day both here in England and more particularly in Germany at Erlangen and in France deep therapy with very hard tubes is being administered.

In 1908 Barkla and Sadler showed that when a beam of heterogeneous X-rays falls upon a sheet of metal, the latter becomes the source of a new supply of X-rays, homogeneous in character, and that the penetrating power of their characteristic radiations is dependent upon the atomic weight of the element from which they are emitted.

This discovery has been applied to the treatment of rodent ulcer by several workers I have myself treated one such case for a local hospital, by the application of zinc ointment just before the application of X-rays

The ulcer healed up quite nicely, but in the absence of further experience with other similarly treated cases, I am not prepared to express an opinion as to whether the presence of the zinc accelerated the cure. I have healed up many other rodent ulcers quite as rapidly with X-rays alone

38. Ruvue de la Tuberculose, April. 1897.

39. Wien. med. Wochens Vol XLVIII, p 1058 1898.

40. At the 22nd Congress of the Duetsche Gesellschaft fur Chirurgie April 22nd, 1897.

41. Edinburgh Medical Journal, Vol XLIX, 1900, p. 139.

42. "The Röntgen Rays in Therapeutics and Diagnosis," by Pusey and Caldwell. Saunders & Co

Rodent ulcers have been healed up by several workers by the introduction of zinc ions by ionization.

I suggest that probably a more rapid treatment for rodent ulcer should lie in a blend of these two treatments, i.e., first to introduce the zinc ions as deeply as possible into the ulcer and the surrounding tissues, and then to apply X-rays in order to bring out their characteristic radiations.

As far back as 1900 Curie and Sagnac showed that the absorption of X-rays by an element is accompanied by the liberation of electrons; this electronic emission reaches a maximum when characteristic radiations are excited. This fact was brought very forcibly to my notice in 1918 when Professor E. A. Owen and myself carried out some experiments in connection with a research he was making on this very subject.[43]

According to Professor Bragg, X-rays themselves are ineffective, and all the chemical and physical changes observable under their influence are to be attributed to the electrons they produce when they are arrested.

KAYE'S POSTULATE.

According to G. W. C. Kaye, the only purpose X-rays serve in therapeutics is to plant the action deeper in the body. He says: "To produce therapeutic action at any particular point, there must first of all be transformation of the X-rays into corpuscular rays (electrons), and then absorption of these corpuscular rays."

Only 23 years after the discovery of X-rays, their medical application had grown to such proportions that in his presidential address to the Röntgen Society in June, 1918, Dr. Kaye made the following statement: —"But the all-important use of the X-rays, and the one most dominant in our minds to-night, is their medical application. Every hospital of any size now has its X-ray department, and there are many thousands of radiologists, both medical and laymen, devoting their lives to the work, and by their aid miracles are literally being wrought daily."

The photographs, shown in Fig. 3, illustrate a few of the cases which have been referred to me for X-ray treatment by hospitals and doctors during the course of my practice.

[Lantern slides of a number of other cures of lupus, rodent ulcer, epithelioma, etc., were shown].

QUANTITATIVE X-RAY MEASUREMENTS.

Several methods have been evolved for more or less accurately measuring the dosage of X-rays, but time will not permit me to enumerate them all. The two outstanding methods now in use are (1) the platino-cyanide of barium colour change method, and (2) the method of measuring the ionization produced

43. See "The Asymmetrical Distribution of Corpuscular Radiations produced by X-Rays." By E. A. Owen. Proc. Physical Society of London. Vol. XXX, Part III. April 15th, 1918.

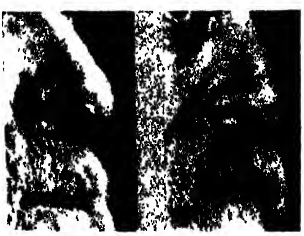
Epithelioma.

Nov. 1st. Cured Jan. 19th.

Rodent Ulcer.

Before Treatment. During. After 11 years after.

Angiomatous Tumour.



Naevus.

Jan. 6th. Feb. 12th.

Papilloma.

FIG. 3.

by X-rays within an ionization chamber by observing the discharge of an electroscope.

Quite recently another method has been invented in Austria at the Strauss Laboratories, Vienna, which makes use of a triode thermionic valve.

The grid of the valve is charged negatively by means of a small transformer; in this condition no current can pass through its plate circuit. An ionization chamber is connected to the grid, which in use acts in similar manner to the grid leak so familiar in radio reception. When the ionization chamber is irradiated, the grid begins to lose its charge more or less rapidly according to the intensity of the rays, owing to the increased conductivity of the air in the ionization chamber as it becomes ionized. As soon as the grid potential has exceeded a certain minimum positive value, an anode current passes through

the valve and operates a relay. This recharges the grid and at the same time operates a clock, a light signal, or any other auxiliary apparatus, that may be required. The process automatically and periodically repeats itself. The time taken will depend upon the amount of the "X" radiation. An exact measurement of the dose can therefore be obtained by the automatic counting of the relay movements.

The instrument has been named by the makers the "X-ray Mecapion."

THE APPLICATION OF CURRENTS OF HIGH-POTENTIAL TO THERAPEUTICS.

Static machines have been employed for therapeutic purposes since the earliest days of medical electricity. Prior to the year 1899, when W. J. Morton, of New York, introduced a new modality[44] known as the "static wave current" (often called after him "the Morton wave current") the treatments were usually either applied locally in the form of static breeze or effleuve, or generally, by charging the patient to a high potential on an insulated platform or couch.

The static breeze from the positive pole of the machine had a sedative effect, and the breeze from the negative pole was employed where stimulation was desired.

Morton's scheme consisted in placing the patient on an insulated platform, and connecting him to one pole of the static machine, the other pole of which was earthed. Under these conditions when the machine was worked the voltage applied to the patient steadily increased until the potential was sufficiently high to break down the air gap between the discharge knobs of the machine (previously set at a suitable distance apart). When this occurred the patient was momentarily discharged to earth, and a powerful but painless contraction of the muscles in the vicinity of the electrode occurred. After the discharge, the potential gradually rose again and the process was repeated ad lib. The intensity of the contractions and the time intervals between their occurrence depends mainly on the distance of the separation between the spark knobs of the machine.

This form of treatment has proved of great value, in the relief of local congestion and hyperæmia, relief of pain, muscular spasm, etc. I have seen surprisingly rapid cures of long standing sciatica, lumbago, etc. I do not, however, wish to give the impression that this treatment is a specific. We all meet with intractable cases at times, and again so much depends upon the primary cause of the trouble, but the percentage of cases that obtain lasting relief is quite high.

Probably by far the greatest boon bestowed by this treatment is the relief which it gives in cases of enlarged prostate gland. The results are truly

44. Bulletin Officiel de la Societé Française d'Electrothérapie. January, 1890. Electrical Engineer, March 4th, 1899. Transactions of the American Electrotherapeutic Association, 1900. "High-potential and High Frequency Currents," by Wm. Benham Snow. (New York Scientific Authors Publishing Co., 1905).

wonderful; in many cases relief is experienced after the first application. Ten or twelve treatments usually give comfort and allow the patient to sleep without interruption through the entire night. I have treated numbers of such cases that have been referred to me by various medical men, and most of them have obtained great relief.

The great drawback with all static modalities is the erratic behaviour of influence and frictional machines in damp weather. I overcame this drawback when in 1910 I devised a method[45] for obtaining static electricity from an induction coil for medical purposes, and also for producing painless static contractions similar to those obtained by Morton from a static machine.[46] While experimenting with this method I took a number of spark photographs[46] to show that the discharges obtained were pure negative and positive, and exactly comparable with those produced by the discharges from a Wimshurst or other type of static machine.

Illustrations A and B in Fig. 4 show respectively a positive and a negative spark photograph. As will be seen, each photograph has distinct characteristics of its own.

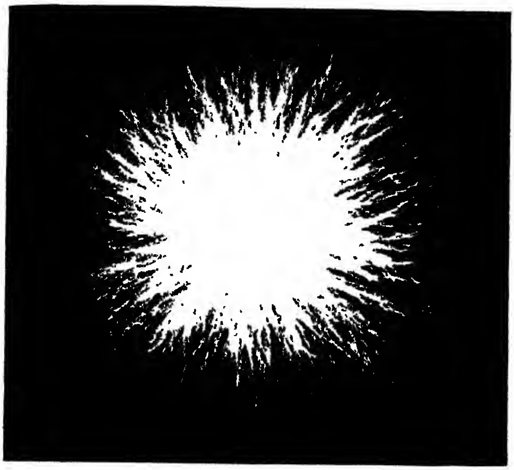
At about this date 1911 a controversy was at its height regarding the results obtained by the application of high-frequency currents. In cases of neuritis, for instance, some workers claimed relief of pain in nearly all cases treated; others obtained very erratic results, and others again, instead of finding improvement, reported that their patients seemed to get worse. The idea occurred to me to investigate the discharges from a high-frequency resonator by aid of spark photographs. Illustrations C and D in Fig. 4 show the results obtained. It will be observed that either negative or positive can be made to predominate, according to the direction in which the current is passed through the primary of the induction coil. or which of its secondary terminals are connected to which of the terminals of the high-frequency apparatus

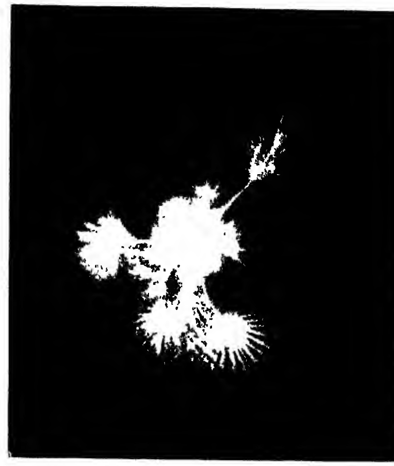
Until I pointed out this fact, connections were made quite indiscriminately from time to time, it being thought that as high-frequency alternating currents were employed, it did not matter which way the connections were made. Since conducting these experiments I have been very careful to connect for negative predominance when stimulation is required and for positive predominance for sedative effects. A distinct improvement in results has been noted.

All sorts and conditions of high-frequency resonators are now on the market, and in my opinion a careful investigation is badly needed in order to standardize

45. British Patent No. 22660/11. (Exhibited for the first time at the British Medical Exhibition at Liverpool, 1912).

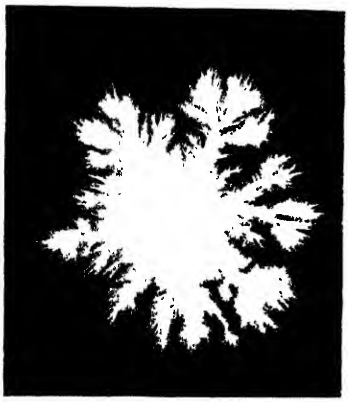
46. For full details and description see "Method of obtaining Static Electricity from an Induction Coil," by G. G. Blake. Archives of Radiology and Electrotherapy, February, 1919. Numerous references re spark photographs are also given. (Recently spark photographs have been very successfully employed in Electrical Engineering for the analysis and measurement of surge voltages on transmission lines due to lightning. Everett S. Lee and C. M. Foust. General Electric Review. Vol. 30, March, 1927, Pp. 135-145. This paper also gives about a dozen references to spark photography).





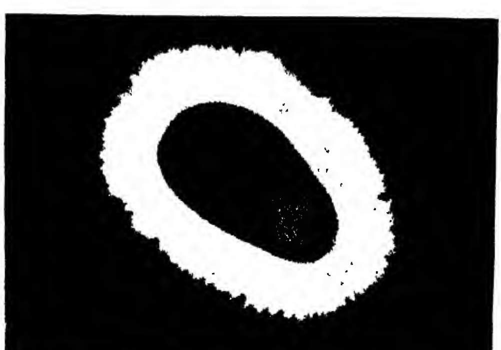
Spark Photographs from Static Machine.

A. Positive. B. Negative.



Spark Photographs from High-frequency Resonator.

Positive Predominating. D. Negative Predominating.



E. An Example of a Fingerprint taken by High-frequency Spark Method (suggested by Author), for Criminology.

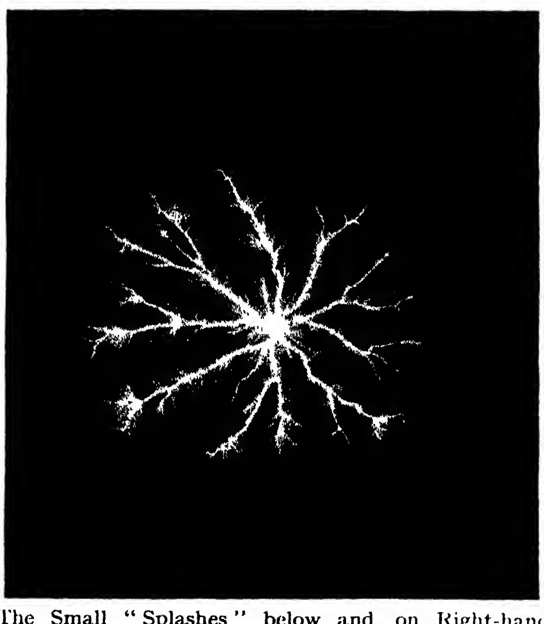
FIG. 4.

and to make sure that the predominance (if any) shall be known and be reversible when required. Oscillographic methods could doubtless be employed in place of the somewhat clumsy spark photographs.

I have a strong feeling that most of, if not all, the therapeutic results we are obtaining are likely to be due to these peak value predominances, and that in reality we are employing our H.F. resonators mainly as a means of obtaining high-potential discharges, similar to those from a static machine. If my ideas on this matter are correct, it might be well worth while to conduct some experiments with a view to increasing the amount of predominance obtainable. I only wish I had the necessary free time and apparatus at my disposal to carry out this and many other electro-medical researches which constantly occur to me.

Spark Photography of Thumb Prints.

I have made a few experiments to see how spark photographs could be made use of in criminology for taking thumb-prints. The example shown in Fig. 4 was taken instantaneously, and shows some possibilities for spark photography in the new field thus opened.[47]



The Small "Splashes" below and on Right-hand Side of this High-Frequency Spark Photograph are due to Groups of "Ions" Projected on to the Surface of the Plate from the Atmosphere.

Fig. 5.

47. Thumb print spark photographs were exhibited for the first time at my lecture to the East Midland Sub-centre of the I.E.E. at Derby. March 20th, 1928.

ADDENBROOKE'S METHOD OF STUDYING HIGH-TENSION DISCHARGES.

The following experiment was shown in January this year by G. L. Addenbrooke[48] at the Exhibition of the Physical and Optical Societies at South Kensington, and it provides us with another means of studying these high tension discharges.

[A view of the surface of a glass vessel filled with "castor oil" was projected on to the lantern screen. Above its centre was a pointed electrode. If the latter was given either a positive or a negative charge, ions of like sign to that of the electrode were projected on to the surface of the oil, and the splashes which they produced could be seen. As in the case of spark photographs the characteristics of the impressions for positive and negative ions were clearly defined]

In Fig. 5 I have succeeded in obtaining a photographic record (round the borders of an ordinary H.F. spark characteristic) of some of the groups of ions thrown down from the atmosphere on to the surface of the plate. It is probable that the sensations one feels from static and high-frequency brush discharges are due to the impact of showers of these ions. The last experiment was in reality an early stage of "electric wind"

I would like to have shown the modus operandi of many other electro-medical applications, but I must refrain as time will not permit.

DISCUSSION.

MR. A. A. CAMPBELL SWINTON, F.R.S., said the lecture demonstrated what a long way had been travelled in the subject in the last 32 years since he had had the pleasure of giving a lecture in the hall of the Royal Society upon Röntgen rays. He was amazed at the complexity of the experiments which had been shown by the lecturer. The ground which Mr. Blake had covered was so enormous that it was really too difficult for one to fix upon any particular point to discuss. He would not delay the meeting by any further remarks, as the time was very late, but he did desire to congratulate Mr. Blake upon a very interesting and remarkable lecture, and upon the success of his wonderful experiments.

THE CHAIRMAN conveyed the thanks of the audience to Mr. Blake for his lecture and for his wonderful series of experiments, on nearly any one of which, no doubt, Mr. Blake could have spoken for an hour. Personally he had had experience of doing lecture experiments, but he had never tried to show so many, one after the other, and with such great rapidity and such perfect success, as Mr. Blake had done. Looking back over the ground which Mr Blake had covered he was surprised that he had been able to get so much into a single lecture.

In the early days of high frequency alternating currents, he himself had used to carry out experiments, and it had been very surprising to notice how those alternating currents, if they were of sufficiently high frequency, were not felt when they passed through the body, even although the voltage was tremendous. Ordinarily if a person had 2,000 volts applied to him he would be very much damaged; he

48. "Splashes on the Surface of a Liquid Di-electric produced by a Point Electrode with Intermittent Field." G. L. Addenbrooke, Phil. Mag., May, 1927.

would feel uncomfortable even with 500 volts driving a current through the body, but high frequency alternating currents might be driven by 30,000 volts. Nevertheless, being so very rapid in frequency they did not seem to have time to do any harm. The alternation was reversed before the nerves or the tissues had time to respond. Although he said that no harm was done by passing such high frequency alternating currents through the body, he did not think it wise continually to repeat such an experiment, because some harm might be done without one knowing of it. He himself had felt lassitude after those experiments.

In his early days he had carried out some experiments in this connection with a frog's nerve muscle, and he had found that though a fraction of a volt applied to the frog's nerve by a steady current from a potentiometer made the muscle twitch; yet when he had applied an alternating current of sufficient frequency, such as one got from the discharge of a Leyden jar oscillating some millions a second, although the voltage might be sufficient to cause sparks, the frog's legs did not twitch. He had also found that if he continued that application of the unfelt high frequency current, and then again tried to stimulate it by the one volt steady current, the frog did not feel that either. The transmissibility of the nerve had been interfered with. An inhibition had been set up in that place which had been subject to the high frequency currents, so that the perturbation which would normally be transmitted to the muscle from the one volt steady current was stopped. There was no permanent damage: it recovered after an interval.

He had visited an electro-therapeutist in Vichy, who had shown him his high frequency treatment there. One method was to put a patient in a coil of wire, round which oscillating currents were sent, but the practitioner did not seem to think that it did his patients much good, and had told him that the patients seemed to benefit more if he put them on an insulating stool and drew sparks from their knees. He had thought it was a sort of auto-suggestion; for when he applied the high frequency current or alternating magnetism, the patient felt nothing, and therefore thought nothing was happening to his complaint, and that he was not getting better, but if the patient saw sparks being taken from his knee he at once thought, " Oh, this is really something like."

He had been interested in perceiving that Mr. Blake seemed to agree with the notion that it was not radiation which acted primarily. Personally he would not expect radiation to act on gross matter directly. Radiation had a tremendously high frequency. The frequency of light oscillations—even of visible light—was not to be reckoned in millions a second but in 500 million millions a second; and the frequency of the oscillations of X-rays was higher still. He would not expect those vibrations to be able to do anything direct, but it was known now that those high frequency waves were entirely competent to eject electrons and to disturb the atom. They were quite capable of beginning a sort of stimulated radio activity, which had been investigated so much medically. It might be that they were stimulating the actual nucleus of the atom—the tumble-down from uranium through new substances to radium and on to lead, where the process seemed to stop. Those things had to be borne in mind.

He thought our own vision depended upon that power of radiation. He did not think we saw by radiation directly. He doubted if it could affect the retina of the eye directly. The retina of the eye contained something from which electrons were ejected when radiation fell upon it, and those electrons, thus projected, were competent to stimulate the nerves. He expected that our nerves were stimulated by the ejected electrons rather than by the wave direct—the photo-

electric action. That, he thought, would be found to be the theory of vision and the way in which the retina acted.

He might be asked what right he had to express any opinion on physiological subjects He had no right at all, and he wanted to guard himself by saying that no one need believe what he had said. He was merely suggesting it in the presence of an expert audience, so that if anything was wrong in what he had said it might be corrected Sometimes suggestions even from a layman were serviceable. At any rate, it was an idea which had a good deal to be said for it. He had no doubt that other people had had the same idea.

Altogether it would be seen that the lecturer had brought forward a subject of great interest, and he was undoubtedly owed a hearty vote of thanks

Mr. G. G. Blake said he was extremely obliged to Sir Oliver Lodge and to Mr. Campbell Swinton for their very kind remarks.

He had been most interested in the experiment of the frog's leg. He was not familiar with it, but he remembered that a frog's leg had been used to record wireless signals, after rectification by a crystal. He thought Sir Oliver's experiment in that connexion might lead to valuable research work being done.

He had also been very interested in Sir Oliver's theory with regard to Milligan's cosmic rays The theory that those rays might be causing the breakdown of atoms and the radio-activity of radium was entirely new to him He would like to ask Sir Oliver if it was to be taken that they might cause the breakdown of other atoms as well as those in radio-active series Were all elements being broken down by those Milligan rays?

The Chairman replied that he thought that most of the familiar substances were stable, so that if they ever did break down and change into others they did so with extreme slowness so slowly that no one knew that it happened. Those that were known to be radio-active were all at the heavy end—so complex that they simplified themselves, but there was more than that to be said about it. Sir Ernest Rutherford had bombarded a nitrogen atom and had knocked it to pieces. It was not merely the whole atom which was hit, but the nucleus, a thing so minute that it was very difficult to hit. Cosmic rays, which were supposed to come from the nebulæ and which were penetrating our bodies and producing some effect (because they did penetrate the earth's atmosphere, 30 inches of mercury would not stop them), might be affecting the nucleus of the atoms. Whether they were affecting the nucleus of ordinary atoms as well as the radio-active, he did not know, but Rutherford had knocked a nitrogen atom to pieces. Therefore all the atoms seemed to be vulnerable if one took the right means of attacking them. Apparently all the atoms were made out of two simple ingredients, built up into architectural structures, and might be knocked down again.

Mr. G. G. Blake said there was one other thing he would like to ask Sir Oliver. He had been present at a lecture given by Mr. Paterson at the Royal Society of Arts on electric lamps, where Sir Oliver had propounded a theory with regard to the possible cause of cancer an electrolytic theory. If Sir Oliver could say a word about that he was sure the audience would be greatly interested.

The Chairman said he had not got the matter in his mind with sufficient clearness at the moment to make it worth while for him to speak about it. It had been a sort of disease of the filaments in lamps to which Mr. Paterson had called attention.

There seemed to be a catalytic growth in the filament of the lamp. The atoms deposited material in a weak place and went back for more, and so on continuously. Mr. Paterson had traced that it was due to the presence of certain substances; he had forgotten what those substances were.

MR. G. G. BLAKE: Water.

THE CHAIRMAN said water was generally at the bottom of all chemical reactions. Water was a wonderful substance. Chemical reactions would not begin if there was no water. Professor Baker had shown that the gases which exploded, like hydrogen and chlorine, under the action of light, would not work at all if they were quite dry. Very often he himself had found that when one took great care over an experiment and got it quite perfect, it would not respond; success had been due to some slight impurity. That was the way to make discoveries. That was the way radium was discovered - by looking out for those residual effects, and discovering why things happened. If there was no water present, even hydrogen and oxygen would not combine. Professor Baker insisted that water was essential to chemical action, and that dryness stopped it. Professor Baker was called by his undergraduates "His Imperial Dryness," so keen was he on the subject. Water in the lamps—if it had been only water—had set up the disease to which Mr. Paterson had referred; and if it was excluded it did not go on. The only thing which he himself had ventured to suggest had been that cancer might be a catalytic growth. The cells misbehaved and formed structures under some catalytic action. The point, however, was too vague in his mind at the moment for him to pursue it. It was very important for people to get to the root of these diseases, and any suggestion should be tolerated as a clue to research. The audience that night had had an example of the researches which were at present going on. It was wonderful what facility for research was forthcoming when practical applications began. When applications to engineering purposes were possible things were done on a scale unattainable by the physicist alone. When applications to medicine were possible, funds were forthcoming and apparatus was made much more convenient than those amateur things which were used in a laboratory. So it was possible to give a lecture like that which had been delivered that evening and which had covered so wide a field.

The proceedings then terminated.

NOTES ON BOOKS.

CHARLES LETTS'S ENGINEERS' DIARY. Edited by J. E. Dodsworth. Charles Letts and Co., Southwark Bridge Buildings, London. Price 3s., or, in refillable case, 6s.

Messrs. Charles Letts's Engineers' Diary is one of the best diaries we have seen, not only for engineers, but for ordinary persons, since, in addition to more technical items, it contains a large quantity of general information of a kind that is useful to everybody. In addition to the diary proper, there are 32 pages of technical and general information, and also a number of blank pages for memoranda, addresses, etc. The diary is printed on thin paper and is barely more than a quarter of an inch thick, so that it may be carried in the pocket very conveniently.

THE STRUCTURE OF AN ORGANIC CRYSTAL: FISON MEMORIAL LECTURE, 1928. By Sir William Bragg, K.B.E., F.R.S., M.A., D.Sc. London: Longmans, Green & Co., Ltd. 1*s.* 6*d.* net.

In the Fison Memorial Lecture for 1928, Sir William Bragg gives an outline of the way in which X-ray methods have been used to investigate the groupings of atoms which occur in the complex crystals of organic substances.

Commencing with a description of crystalline conditions in general, and pointing out that whatever results may be obtained will probably be very largely applicable also to the liquid and vapour states, the lecturer proceeds to a very brief account of the manner in which the crystal lattice gives rise to the well-known interference phenomena in the X-ray beam, leading to regular concentrations of energy in certain definite areas, and hence to the familiar patterning on a photographic plate situated in the path of the rays.

In the case of organic substances, saving only the very simplest, the complication of the molecule is so great that the resulting pattern is too intricate to be fully interpreted in the present state of our knowledge; but even so a quantity of valuable information can be obtained. Open-chain compounds are at present more amenable than cyclic derivatives; but "the experience gained in the study of the chains, limited though it is, has increased the chance of success with the rings; indeed, good progress has been made quite recently."

It is noteworthy that the results are in entire agreement with the views of organic structure formulated long ago, from totally different trains of reasoning, by organic chemists. This is really most fortunate, as one hardly likes to think of the war which would have resulted if things had turned out otherwise; and moreover the event contains a moral for the exponents of that school of thought which takes pleasure in the idea that one has only to wait long enough in order to see the demolition of any conclusion arrived at by the scientific world.

It will not be long, however, before the X-ray methods yield something more than mere confirmation. In their present infancy they cannot be said to do much more than add a number of details to the chemist's picture; but the work is proceeding apace, and there can be little doubt that it will achieve far-reaching results in the near future.

CORRECTION.

In the penultimate line of Engineer-Captain J. C. Brand's remarks, on page 224 of the *Journal* dated January 11th, in the discussion of Sir Eustace Tennyson D'Eyncourt's Paper on "Fuel for Ships," "seven-sixths" should be read in place of "seven-sixteenths."

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JANUARY 21..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Criticism by Mr. Oswald P. Milne on work submitted for Prizes and Studentships.

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. N. Platt, "Safety in Four-Wheel Braking Systems."

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m. General Discussion on "The Anticipation of Demand, and the Economic Selection, Provision and Layout of Plant with introductory papers by Captain J. M. Donaldson ("Power Systems") and Mr. J. G. Hines ("Telephone Systems").

At the University, Edmund Street, Birmingham. 7 p.m. Captain P. P. Eckersley, Lecture on "Wireless."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. J. R. Baker, "The Northern New Hebrides."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. H. R. Sketch, "Engineering Insurance."

At the Merchant Venturers' Technical College, Bristol. 7 p.m. Dr. H. J. Gough, "Recent Developments in the Study of Fatigue of Materials."

Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture VIII—The Alps" (*continued*).

University of London, at University College, Gower Street, W.C.1. 2 p.m. Mr. Norman H. Baynes, "The Historical Background of Hebrew Prophecy."

At University College, Gower Street, W.C.1. 4.15 p.m. Prof. L. M. Brandin, "Le Merveilleux dans la Littérature du moyen âge."

At University College, Gower Street, W.C. 5 p.m. Mr. G. P. Crowden, "Fatigue." (Lecture II.)
At University College, Gower Street, W.C.1. At 5.30 p.m. Prof. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture II.)
Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Rev. Charles Cooper, "Precious Stones of the Bible."

TUESDAY, JANUARY 22..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Messrs. J. H. Hyde and H. R. Lintern, "The Vibrations of Roads and Structures."
Electrical Engineers, Institution of, at 17, Albert Square, Manchester. 7 p.m. General discussion on "The Anticipation of Demand, and the Economic Selection, Provision and Layout of Plant," with introductory papers by Captain J. M. Donaldson ("Power Systems") and Mr. J. G. Hines ("Telephone Systems").
Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, Westminster, S.W. 6.30 p.m. Dr. L. C. Martin, "Colour and its Applications."
Roman Studies, Society for the Promotion of, at Burlington House, W. 4.30 p.m. Mr. S. N. Miller, "The York Excavations of 1926-1928."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. F. A. Freeth, "Critical Phenomena in Saturated Solutions." (Lecture II.)

WEDNESDAY, JANUARY 23..Automobile Engineers, Institution of, at the Engineers' Club, Manchester 7 p.m. Mr. M. Platt, "Safety in Four-Wheel Braking Systems."
British Empire Producers' Organisation, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m. Addresses on Food Products of the Empire: (1) Mr. John Gilliat, "Empire Coffee Industry"; (2) Mr. Archer Warner, "Cocoa in the British Empire."
Geological Society, Burlington House, W. 5.30 p.m. (1) Dr. A. Jowett and Prof. Dr. J. K. Charlesworth, "The Glacial Geology of the Derbyshire Dome and the Western Slopes of the Southern Pennines"; (2) Prof. Dr. J. K. Charlesworth, "The South Wales End Moraine."
Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin. Lecture IX. Ancient Folded (Folded) Mountains."
United Service Institution, Whitehall, S.W. 3 p.m. Brigadier B. D. Fisher, "The Training of the Regimental Officer."
University of London (London School of Economics), at Chesham House, 136, Regent Street, W. 6 p.m. Mr. W. Sansom, "Office Routine to Ledger Posting and Balancing in a Model Office."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture I.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture I.)
At University College, Gower Street, W.C. 3 p.m. Dr. Camillo Pellizzi, "La Divina Commedia: Paradiso." (Lecture I.)
At University College, Gower Street, W. 5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture II.)
At University College, Gower Street, W.C.1. 5.30 p.m. Mr. J. H. Helweg, "The Renaissance Period in Danish History and Literature." (Lecture II.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. P. Geyl, "The Historical Background: Dutch Art in its relation to Dutch Society and Civilisation."

THURSDAY, JANUARY 24..Aeronautical Society, at St. Ermin's Hotel, Westminster, S.W. 7.30 p.m. Informal Discussion on "The Compression Ignition Engine for Aircraft: Wing-Commander G. B. Ayre ("Compression Ignition Engine") and Captain G. S. Wilkinson ("Petrol Engine").
Antiquaries, Society of, Burlington House, W. 8.30 p.m.
Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. Johnstone Wright and C. W. Marshall "The Construction of the Grid Transmission System in Great Britain."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Mr. Gordon Home, "Roman London." (Lecture II.)
University of London, at Bedford College for Women, Regent's Park, N.W.1. 5.15 p.m. Mr. W. Perceval Yetts, "Chinese Architecture."
At King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Meyendorff, "Public Finance in Eastern Europe." (Lecture I.)
At 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Kozyanowski, "Renaissance Poland" (Lecture I.)
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture II.)
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture II.)
At University College, Gower Street, W.C.1. 5 p.m. Dr. H. R. Ing "The Chemistry of Some Natural Drugs." (Lecture II.)
At University College, Gower Street, W.C.1. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture I.)
At University College, Gower Street, W.C.1. 5.30 p.m. Prof. A. F. Pollard, "Cardinal Wolsey." (Lecture III.)
Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. W. G. Constable, "Dutch Landscape."

FRIDAY, JANUARY 25. Electrical Engineers, Institution of, at the Gaiety Theatre, Dublin. 3 p.m. Mr. H. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)
Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. M. J. McCarthy, "Notes on Winches, Derricks and other Lifting Appliances used in Modern Building Construction."
Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. J. E. Lea, "Measurement of Coal Supplies in Small or Large Quantities."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) Prof. C. Vernon Boys, "A Fused Quartz Pendulum Rod for Clocks." (2) Mr. G. W. Sutton, "A Method for the Determination of the Equivalent Resistance of Air-Condensers at High Frequencies." (3) Mr. J. Hartshorn, "The Measurement of the Anode Circuit Impedances and Mutual Conductances of Thermionic Valves."
Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. A. C. Seward, "The Vegetation of Greenland."
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin: Lecture X. Ancient Folded Mountains" (*continued*).
Transport, Institute of, at the Adelphi Hotel, Liverpool 6.30 p.m. Mr. C. C. Taylor, "The Reasons of Development of Road Transport in Recent Years."
University of London, at King's College, Strand, W.C. 5.30 p.m. The Rev. Principal J. Oman, D.D., "The Study of Religion: Lecture III.—Problems."
At the London School of Economics, Houghton Street W.C. 2.30 p.m. Dr. W. Rose, "German Life and Literature from 1770."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Sir Thomas W. Arnold, "The Old and New Testaments in Muslim Religious Art." (Lecture III.)
At University College, Gower Street, W.C.1. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture II.)

SATURDAY, JANUARY 26..L.C.C. The Horniman Museum Forest Hill, S.E. 3.30 p.m. Mr. H. Harcourt, "The Lure of India."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Monsieur E. Cammaerts, "Flemish and Belgian Art—The Landscape." (Lecture II.)

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No. 3975. VOL. LXXVII.

FRIDAY, JANUARY 25th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 28th, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture II.)

WEDNESDAY, JANUARY 30th, at 8 p.m. (Ordinary Meeting.) GEORGE FLETCHER, M.A., F.G.S., M.R.I.A., late Member of the Water Power Resources (Ireland) Committee, "The Shannon Scheme and its Economic Consequences." SIR DUGALD CLERK, K.B.E., D.Sc., F.R.S., Past Chairman of the Council, will preside.

SWINEY PRIZE.

A meeting of the adjudicators of the Swiney Prize, appointed under the will of the late Dr. George Swiney, was held on Friday, January 11th, at the Royal College of Physicians. Sir John Rose Bradford, K.C.M.G., C.B., C.B.E., M.D., D.Sc., F.R.C.P., F.R.S., President of the Royal College of Physicians, was in the Chair. The Chairman reported that the Committee appointed by the Royal College of Physicians had examined the works submitted for the prize and were unanimously of opinion that the prize should be awarded to Sydney Smith, M.D., Regius Professor of Forensic Medicine, University of Edinburgh, for his work "Forensic Medicine."

On the motion of the Chairman, seconded by Mr. A. A. Campbell Swinton, F.R.S., it was thereupon unanimously resolved: "That the Swiney Prize be adjudged to Sydney Smith, M.D., Regius Professor of Forensic Medicine, University of Edinburgh, for his work 'Forensic Medicine.'"

COUNCIL.

A meeting of the Council was held on Monday, January 14th. Present :—Sir George Sutton, Bt., in the Chair ; Sir Charles H. Armstrong ; Lord Askwith, K.C.B., K.C., D.C.L. ; Mr. Llewelyn B. Atkinson, M.I.E.E. ; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I. ; Captain Sir Arthur Clarke, K.B.E. ; Sir William Henry Davison, K.B.E., D.L., M.P. ; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Alexander Gibb, G.B.E., C.B. ; Rear-Admiral James de Courcy Hamilton, M.V.O. ; Mr. John S. Highfield, M.Inst.C.E., M.I.E.E. ; Col. Sir Arthur Holbrook, K.B.E., M.P. ; Sir Herbert Jackson, K.B.E., F.R.S. ; Major Sir Humphrey Leggett, R.E., D.S.O. ; Sir Philip Magnus, Bt. ; Sir Reginald A. Mant, K.C.I.E., C.S.I. ; Sir Richard Redmayne, K.C.B. ; Mr. James Swinburne, F.R.S. ; Mr. Alan A. Campbell Swinton, F.R.S. ; Mr. Carmichael Thomas, and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

A resolution of sympathy was passed on the death of Sir Henry Trueman Wood, M.A., formerly Secretary of the Society and afterwards Chairman of the Council.

The following candidates were duly elected Fellows of the Society :—

Aggiman, Jacques N., B.Sc., Angora, Turkey.
Bailey, Cornelius Oliver, M.D., Dallas, Texas, U.SA.
Barrow, G. C. R., London.
Blyth, George Edward Kevin, Ph.D., B.Sc., F.C.S., London.
Bousfield, Arthur, B.A., M.D., London.
Britain, Frank, London.
Budd, Herbert Ashwin, A.R.C.A., R.O.I., London.
Cadbury, Miss Dorothy Adlington, Bournville, Birmingham.
Child, Stephen Ambrose, M.A , B.C.L., London.
Christopher, James, Wetbank, Transvaal, S. Africa.
Cross, A. J., Bombay, India.
Davies, Rev. W. Tudor, West Wickham, Kent.
Fairfield, Commander Percy, R.N.R. (retd.), London.
Fairhurst, Lieut.-Colonel James Ashton, T.D., M.A., J.P., Newbury, Berks.
Ferrier, Henry T., Thornton Heath, Surrey.
Foxton, William, London.
Giles, Godfrey, London.
Girgis, Girgis Ibrahim, Port Tewfick, Egypt.
Haralampides, Michael Kleanthous, Paphos, Cyprus.
Hawken, Captain Cyril Charles Hamsworth, Bickley, Kent.
Kora, Popatlal Dahyabhai, Dharampur, India.
Lambert, Walter, Montreal, Canada.
Lyndon, Lamar, New York City, U.S.A.
McElhanney, T. A., Ottawa, Canada
Millett, Captain J. L. Vivian, London.
Naudain, Willis A., Wilmington, Delaware, U.S.A.
Nelson, Fred N., London.
Sinclair, Francis Richard, Belfast.
Wiles, The Right Hon. Thomas, P.C., London.

Sir Frank Warner, K.B.E., was appointed to represent the Society at the Centenary celebrations of L'Ecole Centrale des Arts et Manufactures, which are being held at Paris in May.

Preliminary consideration was given to the award of the Albert Medal for 1929.

The Report of the Joint Committee of Royal Society of Arts and the Royal College of Physicians recommending the award of the Swiney Prize to Sydney Smith, M.D., Regius Professor of Forensic Medicine at the University of Edinburgh, was approved.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JANUARY 16th, 1929. DR. MARGARET FISHENDEN, D.Sc., F.Inst.P., of the Fuel Research Division, Department of Scientific and Industrial Research, in the Chair.

A Paper entitled "The Domestic Smoke Problem— a Practical Solution," was read by PROFESSOR CHARLES R. DARLING, A.R.C.Sc I., F.I.C., F.Inst.P. The paper and discussion will be published in the *Journal* on February 15th.

CANTOR LECTURES.

MONDAY, JANUARY 21st, 1929. DR. R. LESSING, Ph.D., F.C.S., in the Chair. DR. C. H LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the first of his course of three lectures on "The Treatment of Coal."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By FRANKLIN KIDD, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

LECTURE I. REFRIGERATION IN NATURE.

(Delivered 12th November, 1928).

THE SUBJECT.

In Refrigeration there are perhaps three main divisions of interest. First, there is the engineering aspect ; the mechanical production of low temperatures

in theory and practice; the properties and uses of insulating materials; the design and construction of refrigerating plants for various purposes. Secondly, there are the manifold uses to which the mechanical production of cold for the control of temperature and humidity are put in the manufacture of commodities, when at some stage or other of the process accurate control of temperature or humidity is of importance.

Lastly, there is that aspect of the subject in which we are concerned with the reaction of perishable food products, of plant and animal origin, to low temperature and to such other environmental controls as can be applied before, during, or after storage. It is with this aspect of the subject that we shall mainly be concerned in these lectures.

So much for our topic in general, but before going further, may I draw your attention to an antithesis which exists between science and industry, between knowledge and practice. It is an antithesis of motive in the human mind. When the interest is in industry, success in industry is the measure of achievement, and there can be but one criterion applied to knowledge:— Is it of any use? When interest is in knowledge, the goal is an abstract one. Satisfaction is not related to success in practical affairs. It lies solely in achieving a wider and more unified understanding of the nature of things.

FROM THE POINT OF VIEW OF INDUSTRY.

There are thus in our subject two entirely different approaches, which, however, subtly interlock.

There is the practical man's approach. Here we start with the elementary knowledge acquired by human experience that food products will keep better in cool weather than in warm, and we apply mechanical refrigeration which will give us a cool environment. We make the environment as cold as we can, with the broad distinction, based on common knowledge, that you cannot usually freeze a living plant without killing it and destroying its obvious properties; while dead carcasses can be frozen without altering in any striking manner the condition of the product.

When, however, these broad conclusions from general experience are applied, minor difficulties are met with and modifications in practice are developed as the result of more intensive experience. For example, complications arise from massing products together in the most confined space possible. Questions arise as to what is precisely the most efficient or optimum temperature at which to store various products. Freezing is found to have different effects on the muscle tissue of different animals.

Nevertheless refrigeration as a method for food preservation has been one of the industrial successes of the age. The number of products commercially handled under refrigeration is constantly increasing, and practically all the possible means by which cold can be applied have been tried, e.g., by forced air circulation, by simple exposure to cold pipes and by immersion in cold liquids.

From the industrial point of view, therefore, there is to-day concreted, as it were, round the simple fact that products are either chilled or frozen, a mass of technique varying in detail according to circumstances. The technique in any case is generally not an ideal one, but the best working compromise at present known, considering the vast number of variables usually attaching to any particular case.

The first possible method of approach would therefore yield a descriptive text-book in which particular products, producing centres and trade routes would be dealt with in turn; describing first what had emerged from empirical trials as to ideal treatment, and secondly the actual technique employed commercially in the stores, railways and markets.

From the Point of View of Science.

The other method of approach is that of the scientist. The biologist is concerned with the properties and behaviour of living organism. He attempts to describe in terms of physics and chemistry the sequence of growth, maturity, senescence and post-mortem decay. His object is to establish the laws by which behaviour is regulated in relation to environment and heredity.

From the biological point of view we can say at once that the fate of a food product must depend in the main on three variables—its racial character, its pre-storage nutrition and the temperature during storage. There are of course other storage factors such as humidity, the composition of the atmosphere, mechanical accidents of treatment, handling, etc., but these three are the most fundamental and important. You will observe they are all factors under human control.

You will observe also that, at the outset of any scientific study of refrigeration from the biological point of view, the field is extended to the pre-storage conditions, which determine the inherent nature of the product when it first comes into contact with refrigeration—its " inherent vice " or virtue.

Refrigeration in Nature.

An interesting introduction to the study of low temperature effects upon plants and plant produce is to be found in the great field laboratory of nature.

Let us consider the striking phenomenon of winter hardiness in plants. The broad features of the phenomenon are simple. Plant life as a whole possesses no heat regulatory mechanism or means of locomotion and is at the mercy of the temperature conditions of its environment. We find certain plants existing at temperatures many degrees below the freezing point of water. The leaves of evergreens during the severe conditions of a northern winter in Canada or Norway survive many degrees of frost. On the other hand there are many plants which cannot withstand freezing temperatures at all. Such forms are especially common among species adapted to growth in hot countries. We may, therefore, set ourselves the problem of ascertaining what special

properties are associated with the power of resistant forms to survive and preserve their living protoplasm intact when ice is formed in the tissue, or alternatively, what it is associated with ice formation which so easily kills non-resistant forms.

Allied to this phenomenon of the capacity or lack of capacity to tolerate freezing temperatures is the interesting fact that many plants cannot tolerate for long low temperatures, even when they are above the freezing point.

The Economic Significance of Winter Hardiness.

Owing to its greater economic significance the subject of winter hardiness or frost tolerance has received up to the present the most attention.

To producers the winter hardiness or cold tolerance of their trees and crops is often a matter of critical importance. Let me take two examples, cereal crops and fruit trees. In Canada and the United States they speak of test winters. Such were those ending the years 1872, 1884, 1898, 1917 in the North west, and in addition to the above also 1876, 1895 and 1903 in the East. During these test winters damage to fruit trees was often widespread and disastrous. After the severe 1906 winter a survey of 950 orchards in Maine showed 24,000 trees killed outright out of a total of 443,000, that is, about 6 per cent. As many more again were injured.[1]

The growers of the two staple crops, lucerne or alfalfa and wheat, the one of fundamental importance to the livestock industry and the other for the supply of bread, are faced in the northern parts of the U.S.A. and Canada with the same problem and hazard as the fruit growers—the problem of obtaining winter hardiness in their crops and the hazard of loss by winter killing. Winter killing is practically the only factor which limits the growing of winter wheat in the northern regions. It is not surprising, therefore, that a considerable amount of attention has been paid, especially in U.S.A. and Canada, both to the theoretical and practical aspects of this subject of winter hardiness.

Frost Tolerance Artificially Induced.

As soon as we begin to examine carefully in particular cases the reaction of various plants to the natural refrigeration of nature a number of generalisations come to light. We find in the first place that many plants which are immediately killed after even the mildest exposure to frost when such exposure overtakes them suddenly, as when removed from a warm greenhouse, can nevertheless withstand quite severe freezing conditions if they are " educated " to them by stages through intermediate temperatures. This is the process which growers term hardening. Withholding water from the roots for a period produces similar results.

A single experiment out of many carried out by Harvey in 1918 may be quoted, especially with reterence to the effect of low temperature in inducing

[1] Morse, W. J. *Me. Agric. Stat. Bul.*, 164, 1909.

cold tolerance.[2] It is sufficiently striking. Harvey took two lots of young cabbage plants, grown in a warm bed. One lot he placed at a low temperature, 3°C., or about 38°F. The other he kept at 18°C. or about 70°F. Then at intervals he took specimens from each of these lots and exposed them to extremely severe freezing conditions for half-an-hour. The result was clear cut. The plants removed directly from the warmth to freezing conditions were without exception killed. Of the plants which had been allowed to harden during 5 days at 38°F., all survived, though exposed to the same degree of frost for the same length of time, and although in this exposure they had been frozen stiff.

AGE AND FROST TOLERANCE.

Again on the whole it may be said that the younger the tissue, the more able it is to survive exposure to low temperatures and the formation of ice. Perhaps I may remind you here that plants as distinct from animals are perennially young. They possess growing points, masses of undifferentiated cells rich in protoplasm, which, by continued multiplication and subsequent differentiation, build up what is in essence an infinite series of repeated parts, each part partially and sometimes wholly, after a certain stage, independent of the series as a whole. In any plant, therefore, there may thus be at the same time tissues and cells at the two extremes of the life cycle; some essentially as youthful as the products of the first division of a fertilised egg cell; others on the point of death, wonderfully modified in appearance and form after a life of stressful experience.

Here then is an observation made categorically by Martin of the Bureau of Plant Industry of the U.S.A. after a very thorough study of the comparative hardiness of different wheats.[3] "The crown is the most hardy portion of the wheat plant above the surface. Young leaves are more hardy than old leaves and the bases of leaves (i.e. the youngest parts) are more hardy than the tips." Or again there is the conclusion reached by Winkler after a long series of experiments with plants in freezing mixtures both during summer and winter.[4] "The youngest leaves of evergreens are more cold resistant than the older." The natural life of the leaves of the evergreens, as you know extends to three or four years, so that these leaves afford convenient material for studying the problem of age and cold resistance in plants. The great cold resistance of the embryonic cambium tissue as compared with the wood or bark in dormant trees has been frequently noted and accounts for the recovery of trees after severe injury.[5]

The influence of frost tolerance may be obscured owing to differences in the state of dormancy in tissues of different age.

[2]Harvey, R. B. *Jour. Agric. Research*, 15, 1918.
[3]Martin, J. H. *Jour. Agric. Research*, 35, 1927.
[4]Winkler, A. *Jahrb. für Wissenschaft. Bot.*, 52: 467-506. 1913.
[5]Chandler, W. H. *Mo. Agric. Exper. Stat. Research Bul.*, 8, 1913. *Proc. Am. Soc. Hort. Sci.*, 1918.

DORMANCY AND FROST TOLERANCE.

Another generalisation of interest and significance is that dormant, as opposed to active tissues, are far more hardy. The rest period in plants, in which young as well as old tissues equally participate, is a very interesting phenomenon. It has been studied most in the case of woody plants whose natural habitat is in the temperate zones, and in the case of seeds. Recently in the Missouri Agricultural Experimental Station some 300 species of woody plants were submitted to very thorough investigation with regard to this point. The phenomenon is briefly this. As Autumn advances there ensues a slowing down of cell activity. The causes which induce this resting stage are not very well understood, but, in general, experiment and observation point to two main conditions which are effective, (1) drying, that is to say the withholding or removal of water and (2) exposure to temperatures which are low but above the freezing point. One may note that the two conditions which are broadly associated with the induction of the dormant or resting state are identical with the treatments, well known to growers, which are used to harden plants when they are transferred from hot-house conditions to the open and to the liability of exposure to frost.

There is, however, much evidence of an inherent periodicity in plants, in alternation between rest and activity. Equatorial regions with uniform temperatures present the phenomenon of plants, some in the resting stage while others are in growth. Sometimes, even on the same tree, one branch may be resting, while another is in active growth.

When once the dormant condition is established, it is not broken merely by establishing artificial spring conditions, for example, by bringing cut branches or whole plants into the green-house.

In the Missouri investigation 300 species of woody plants were found to have a definite rest period, and it was, moreover, clearly shown that the length, onset and intensity of the rest period were (as judged by the intensity of measures needed to break it) definite racial characters distinguishing varieties and species.

Numerous observations appear to establish definitely the main thesis that tissues are better able to withstand freezing temperatures when in a dormant state, and the following figures illustrate the progress and magnitude of the phenomenon.

Some experiments of Chandler and of Strausbaugh are interesting. Chandler estimated first the relative cold tolerance of a number of peach varieties by studying the percentage of buds killed in the severe winter of 1905-6. In the following year he took shoots in the winter and estimated the number of buds which could be forced into development at different dates. There appears from his results a rough parallelism between the stability of the resting state in different varieties, and the degree of resistance to severe winter conditions.[6]

[6]Chandler, W. H. *Mo. Agric. Exper. Stat. Bul.*, 74, 1907.

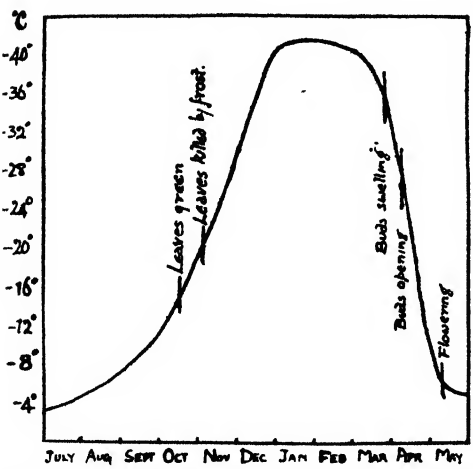

FIG. 1.—Seasonal variation in the killing point of shoots of an apple tree of the Jonathan variety. In the experiments on which this curve is based the shoots were cooled in a refrigerator at the rate of 5° C an hour and exposed 3 hours to the test temperatures. The temperature was then raised at the rate of 5° C. an hour and shoots after thawing examined for injury. (Hildreth.)

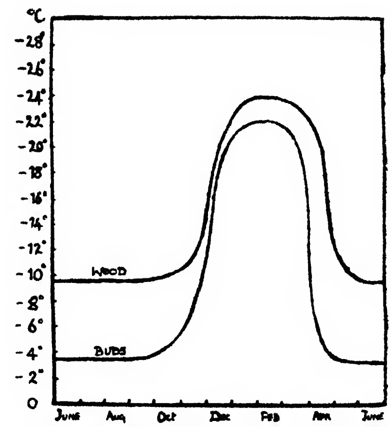

FIG. 2.—Winkler's Summary of his experiments carried out with the shoots of a large number of different species of deciduous trees.
The curves represent the seasonal variation in the depth of freezing required to kill in a typical case, *i.e.*, *Populus nigra*. Cooling time 1 to 3 hours: duration of exposure 9 to 11 hours.

Variety.	Percentage of buds winter-killed.	Percentage of buds which could be forced into growth on December 22nd.
1	39·7	40·7%
2	44·3	6.7
3	51.2	13.0
4	50.6	8.7
5	79·1	86.7
6	78.9	65·7

Strausbaugh on the other hand took plum twigs from varieties known to be hardy and from others known to be tender and found that while he could force the latter into growth and flowering during the winter, the former did not react.[7]

NUTRITION AND FROST TOLERANCE.

Let us turn next to the question of nutrition. Can any generalisation be made as to the effect of particular factors in nutrition upon capacity to maintain the structure of the living protoplasm intact in the face of extreme cold and ice

[7]Strausbaugh, P. D. *Bot. Gaz.*, 71, 1921.

formation? Can we even say that nutrition has any effect at all upon this property. Unfortunately I cannot point to you any actual experiments bearing upon this issue, but there are certain observations which are interesting and suggestive.

For example it has been noted by many and put on definite record by Macoun, that fruit trees are much more susceptible to frost damage after a heavy crop, than when they have borne no fruit the previous autumn. I give you one of his observations. "Of fourteen trees, the eight which bore a medium to good crop in 1917 were killed or badly injured while the six which had either a light crop or no crop at all, came through in good condition."[8]

Pruning and manurial practices very definitely affect winter hardiness. But here the effects, as shown in Nature's laboratory, are difficult to unravel because of the effect of these treatments upon the onset of the resting state independently of any effect they may have on the capacity to withstand specific temperatures at specific stages in rest or activity. Looked at from the horticultural point of view, which is the one from which these phenomena have been most studied, fruit trees according to the district they are growing in are either more in danger of frost in autumn before they have entered their rest stage, or more in danger in spring from the fact that the natural term of rest ends before frosts severe enough to injure are over. Variations in natural conditions or artificial treatments which come under nutritional factors and which favour winter survival are generally believed to do so by either postponing or accelerating the onset of the rest period.

Race and Frost Tolerance.

The last general feature to be described with regard to winter hardiness is the influence of race. You understand of course the contrast between fruit trees of any given variety and a species such, for example, as the oak. All the trees of any given variety of fruit tree are reproduced vegetatively by grafts from one original, and are, therefore, genetically, but a single individual arising from a single fertilised ovum. Within a species, however, every individual that arises from a seed, that is, from a fertilised ovum, is probably racially distinct in some degree from every other individual.

The animal breeder or the breeder of plants propagated by seed is always faced with the difficult problem of fixing the strain. The fruit grower has generally an easier solution. He simply cuts pieces from his selected parent plant and gets them to grow either by sending out roots of their own or grafting them on to other already rooted plants. Though it is common with vegetables there are few fruits which are grown from seed.

An interesting example which illustrates the range of genetic variation within a single species in relation to the property of winter hardiness may be quoted. Wentling, of the Department of Forestry of the University of Min-

[8] Macoun, W. T. *Proc. Am. Soc. Hort. Sci.*, 1918.

nesota, collected native seeds of *Quercus rubra*, a species of oak, from the southern, central and northern regions of the natural distribution of this species in North America, and planted them all together for comparison in the northern region. They all made good growth in the spring and summer after planting. But the effect of the ensuing winter was clean cut. All the seedlings originating from Southern seed were killed, roots and tops ; those of central origin were killed to the snow line, while those from the north were uninjured.[9]

The result of this striking experiment may perhaps be due partly to the existence of racial variants as regards the time of onset and duration of the rest period, as well as upon racial variation as regards capacity for resisting cold.

That racial variants within a species exist with regard to the specific capacity of withstanding cold seems well established from much human experience and vast and costly experiment with apple varieties. We can regard the many varieties of apples as racial variants within the species, isolated or fixed by artificial propagation (eliminating the sex stage of ovum and fertilisation). Among these variants there exists a wide and marked difference in the capacity to resist injury from frost. There is a northern limit to the cultivation of every variety. Certain Crab apples can probably penetrate further to the north than any cultivated variety. The variation in frost tolerance between different cultivated varieties has recently been clearly demonstrated by artificial freezing tests in refrigerators.

Breeding and Selection for Storage Properties.

The fact that the capacity to withstand freezing temperatures is a genetic factor, may be of particular importance in relation to cold storage, because it suggests at once the possibility of breeding and selection as a method of improving storage quality in many types of animal and plant produce.

We shall see later that one of the most important storage qualities in fresh fruits is their capacity to tolerate for long periods low temperatures *above the freezing point*, and that this quality also is inherited. More will be said on this matter in my next lecture. It will be sufficient for the moment to state that it is becoming increasingly clear that for living products there exist critical lower limits of temperature, below which they cannot be stored for any considerable period without depreciating in flavour and condition, or even actually breaking down and becoming inedible.

Since so many of our commercial fruits are reproduced and multiplied merely by subdivision of the bodies of individuals and not by the production of male and female cells and the growth of new individuals from fertilised ova, a word must be said about the origin of new race variants in such cases. Many careful observations have definitely established the fact that permanent bud-variants, that is somatic racial mutants, do arise occasionally and that in some species they arise and are arising much more frequently than in others.

[9] Dorsey, M. J., and Bushnell, J. W. *Proc. Am. Soc. Hort. Sci.*, 1920.

If such mutation is in regard to characters not revealed under their existing conditions, for example, in regard to cold storage qualities, they must pass unnoticed and gradually accumulate in the population from which the grower is continually renewing and multiplying his plants for cropping.

With the world wide industrialisation of production and distribution, storage of produce of all kinds has become a pivotal operation. But while the properties of plants and animals in regard to yield and certain aspects of quality, have long been studied, those particular qualities which render them good or bad keepers in storage have only come under notice as of first rate importance within recent years.

You will follow then the broad trend of my suggestion. Just as other desirable properties have been obtained and improved by breeding and selection, so may those properties associated with good keeping in cold storage.

But to-day the modern world, under the guidance of the scientific method, is not prepared to leave this development to the vast cumbersome process of natural selection by trial and error in the industrial arena. Rather will low temperature research and storage research stations in all the leading countries of the world be employed in order to submit to definite trial and standardisation the storage qualities of new racial variants produced by the breeder.

The Physiology of Frost Injury.

We turn now to consider why it is that freezing is so often followed by injury or death. We may first ask how and where does the ice form in the tissues.

In general, the usual position for ice formation is between the cells. Less frequently is it found within the cell, in the vacuole enclosed by the living protoplasm. Here is a description of his observations by Wiegand, who investigated the ice formation taking place in the buds and twigs of fruit trees.[10] " The ice . . . usually formed a single continuous layer throughout the mesophyll of the scale or leaf, to accommodate which the cells were often separated to a considerable distance. This ice sheet was composed of either one or two layers of the prismatic crystals, depending on the water content of the adjacent surfaces, and was often as thick as the whole normal scale. The cells surrounding the ice, having lost their water content, were in a more or less complete state of collapse, depending upon the resistance of the walls, and often occupied a space smaller than the ice itself. These cells were uninjured, however, and would resume their normal condition on thawing . . . In young anthers the ice often filled the entire anther cavity and in it the pollen grains were imbedded in a completely collapsed state." In general, the species in which ice formed most readily had larger cells, a higher water content and a greater proportion of water to cell wall and protoplasm.

[10] Wiegand, K. M. *Bot. Gaz.*, 41, 1906.

"In the twigs," Wiegand states, "ice is also present in very cold weather, where it may be found in three different localities. The largest quantity occurs in the cortex, where the ice crystallizes in prisms arranged in single or double series. The ice is more frequently in the form of a continuous ring, or really a cylinder, extending entirely around the twig, prising apart the cells of the cortex in which it lies. The outer cylinder of cortex in such twigs is completely separated from the inner layers when frozen. In a few species instead of the continuous layer, lens-shaped ice masses are interpolated irregularly throughout the cortex. The cortical cells after the withdrawal of water are as completely collapsed as were those in the bud scales, but they also usually regain their normal condition on thawing. In the wood ice rarely forms in large quantities. It is usually confined to small masses in the vessels themselves, or, according to some authors, sometimes extends in radial plates in the pith rays. In sectioning twigs, I, myself, have never seen ice in the wood elsewhere than in the vessels or wood cells. In the pith the ice, so far as I have been able to observe, always occurs within the cells and therefore in very small masses."

Müller-Thurgau, a pioneer observer in the field of the effects of low temperatures upon plants, showed as long ago as 1880 that rapid freezing tends to produce small and irregular ice crystals while slow freezing larger and more regular ice masses. He associated the formation of ice inside the cells with rapid freezing.[11]

FROST INJURY AND THAWING.

The earliest investigators held the view that it is only on the thawing of the ice that the fatal disorganisations of frost injury set in. This view, in its absolute form, was eventually disproved by the observation of post mortem effects in the still frozen tissues. There is a red marine alga Nitophyllum which on death and consequent disorganisation exhibits a brilliant orange red fluorescence. When cooled to —5°C., this fluorescence soon becomes obvious. The unnatural and often disagreeable odours and flavours which develop in some fruits while frozen are probably post-mortem products. The browning of frozen apple tissue or of frozen plums, which slowly occurs when these fruits are kept frozen, are certainly post-mortem changes.

In recent investigations the question of the rate of thawing has been considered and there is evidence that rapid thawing may sometimes cause injury, that is to say, injury which would not occur, if the thawing were slow. Here are the results of some experiments carried out by Hildreth.[12]

"Wealthy" apple shoots frozen for three hours at —35°C.

[11]Müller-Thurgau, H. *Landw. Jahrb.* 9, 1880; 11, 1882; 15, 1886.
[12]Hildreth, A. C. *Minn. Agric. Exper. Stat. Tech. Bul.*, 38, 1926.

Rate of Cooling.	*Rate of thawing.*	*Relative injury.* %
5°C. per hour	Rapid. By immersion in water at +15°C.	64.4
,,	Rapid. By immersion in mercury at +30°C.	65.5
2.5°C. per hour.	Slow.	8.8

FROST INJURY AND DESICCATION.

The older view that thawing caused the injury was succeeded by the hypothesis that death and disorganisation were to be traced to the effects of the desiccation which resulted from the withdrawal of water in the formation of ice. It is well known of course that in the case of most plant tissues, desiccation results in the disorganisation of the living mechanism and consequent death.

In tissues which can withstand desiccation, such as seeds, slow changes go on in the dry material. These changes are irreversible and end in the destruction of the living organism. Different seeds have very different life-durations in the dried state, that is to say, the time they remain viable or able to germinate on addition of water differs.

In the same way it has been found that the duration of exposure often has a pronounced effect on the degree of injury resulting from freezing. One may again quote Hildreth, taking his observations on terminal buds slowly cooled and held at —30°C. for three hours as compared with twelve hours.[13]

Apple variety.	*3 hours.*	*12 hours.*
Winesap	dead	dead
Wealthy	no injury	dead
Duchess (Oldenburg)	no injury	dead
Hibernal	no injury	nearly dead.

Mez, in 1905, as the results of his experimental work in cooling plant tissues to —14.5°C. reached the conclusion that death by cold desiccation was only exceptional.[14] Mez was one of the earliest to pay close attention to cooling curves. He found that in cooling, the tissues he observed behaved exactly like solutions of their constituent substances. Their temperature first fell rapidly till ice began to form; then slowly during the slow concentration of the solutions and consequent lowering of the freezing point, until it became approximately constant, at which stage ice and solute crystallised out together. Only finally, when the whole mass was solid did the temperature fall again. Mez found —6°C. to be the apparent eutectic point and argued that at this temperature " cold desiccation " must be complete, and that no further injury from this cause was possible by further cooling. The conclusion he reached from his experiments in cooling to —14.5°C. was that low temperature had a specific effect independent of desiccation and that there was a different fatal minimum temperature for different cells and for different classes of tissue.

[13]Hildreth. *Loc. Cit.*
[14]Mez. *Flora*, 94, 1905.

Frost Injury and the Effect of Concentrated Salt Solutions in the Tissues.

Gorke's experiments must next be considered.[15] He took up the point as to the effects which the solutions of the salts in the sap, concentrated after the separation of ice, may have upon the colloidal condition of the protoplasm. Natural proteins are known to be precipitated by concentrated neutral salts. The precipitates become permanent after a time. They can be re-dissolved by dilution only if this is not too long delayed. Gorke submitted the expressed sap of tender and hardy plants to low temperatures and obtained permanent precipitates of protein, the temperatures required ranging from —3°C. for a tender plant like Bryonia, —15 for winter rye, to —40°C. for Pine needles.

Another possible effect of salt solutions, when concentrated under the influence of ice formation, is their solvent action upon certain constituents of the colloidal complex of the living protoplasm. Dr. Moran's recent work at the Low Temperature Research Station on the irreversible changes which are associated with the freezing of the yolks of eggs is extremely interesting in this connection.[16] A frozen egg yolk on thawing is found to have lost its original fluid condition, and to have become tacky and pasty in consistence much as if it has been " soft " boiled. Dr. Moran's researches indicate that the lecitho-vitellin complex in the colloidal aggregate is dissolved out in the concentrated solution of salts formed after the separation of ice. Upon thawing and consequent dilution precipitation takes place. Experiments with lecitho-vitellin, as an isolated substance, show that it is dissolved in a 10 per cent. solution of NaCl and that it is thrown out of solution and precipitated by adding water. The freezing point of a 10 per cent. solution of NaCl is about —6°C., and this is the critical temperature below which the yolk must not be carried in the frozen state if the irreversible change described above is to be avoided.

Frost Injury and the Rate of Cooling.

Two sets of experiments, one by Kühne and the other by Molisch, illustrate the striking degree to which the rate of cooling may influence the phenomenon of ice formation and frost injury in plants.[17] In the fine hairs that grow on the stamens of some plants, (*Tradescantia Virginica* was used by Kühne and *Tradescantia crassula* by Molisch), the living protoplasm maintains an active streaming movement. Kuhnë froze these hairs rapidly in a platinum crucible which he placed in a freezing mixture at —14°C. They are so small that their freezing must have been practically instantaneous. Ice formed throughout the

[15]Gorke, H. *Landw. Vers. Stat.*, 65, 1907.

[16]Moran, T. *Proc. Roy. Soc. B.*, 98, 1925; *Proc. 4th Cong. of Refrig.*, 1, 1924.

[17]Molisch, H. *Untersuchungen über das Erfrieren der Pflanzen*, Tena, 1897. Kühne, W. *Untersuchungen über das Protoplasma*, Leipzig, 1864.

cell and on thawing active streaming movements in the protoplasms were re-established within ten minutes. In Molisch's experiments freezing was slow; 30 minutes elapsed before ice began to form, after the material was placed on the stage of the microscope under freezing conditions. After thawing, the cells were quite dead.

In contrast to the above, several investigators using more bulky material have found less injury after slow freezing. Winkler, for instance, found that he killed beech (*Fagus sylvatica*) and oak (*Quercus pedunculata*) buds by taking shoots immediately to —22°C. or lower ; but when he allowed them to remain 3 days at —16°C., 3 days at —18°C., 3 days at —20°C., 2 days at —22°C. and 3 days at —25°C. they finally withstood without injury 12 hours at so low a temperature as —30°C.[18] Similarly, dormant apple twigs have been found much less injured by cooling at the rate of 5°C. an hour to —35°C. followed by 3 hours, exposure to this low temperature, than similar shoots taken suddenly to —35°C.[19]

PHYSIOLOGY OF FROST TOLERANCE.

The last topic to be dealt with here is that of the changes which underlie the increase of cold tolerance during the hardening process. This topic must be introduced by a very brief consideration of temperature co-efficients. Every chemical or physical change, other things being constant, goes on at a definite rate which depends upon the temperature of the system in which the change is occurring. The higher the temperature the faster the rate. But all individual chemical or physical changes are not affected by temperature to the same degree. In a system or machine consisting of a series of linked changes, one change depending on the product of another, such as we believe the living cell to be, a change of temperature will, therefore, not only effect the net speed of the whole, but also the balance of the parts. Change in the balance of the parts will reveal itself in a change in composition. There will be more of some products and less of others present at any time.

The effect of lower temperature for reducing the net speed of the complex of changes which produce ripening, growth, senescence and post-mortem decay is, of course, the effect of temperature upon which cold storage practice primarily depends. The change of balance and in composition produced by low temperatures is, however, a subsidiary effect which is of great importance. It is of special importance in regard to the influence of cool storage upon the quality of the produce, that is to say, upon the relative content of sugar acids, proteins and fats and aromatic flavouring substances. It is of special importance, also, in regard to the injurious effects which may be produced by long exposure to low temperatures (above the freezing point) and with regard to the ability to resist freezing and survive ice formation. How important to biological

[18] Winkler. *Loc. Cit.*
[19] Hildreth. *Loc. Cit.*

organisms is this question of the balance of their physico-chemical systems and the effect of temperature upon this balance, may be illustrated by the high degree of specialisation in temperature control exhibited by the mammals. The human body, for example, is one of the most marvellously adapted thermostats in existence.

INCREASE IN SUGAR CONTENT AT LOW TEMPERATURES.

With this slight theoretical introduction let us return to the laboratory of Nature and consider Lidforss's observations on the winter-green flora of South Sweden.[20] Lidforss found that in the leaves of cold tolerant plants—often apparently delicate herbaceous annuals such as Veronica, Senecio, Viola and Fumaria—there was one outstanding general characteristic in winter. All the starch which is present as a large component in the tissue in summer was transformed to sugar. He set up the thesis, therefore, that cold tolerance was associated with a change in balance leading to the accumulation of sugar at the expense of starch and set out to check his thesis by further observation and experimentation. He showed that by keeping cut leaves with their stalks in sugar solutions for a few days, and so getting them to take up sugar, they were rendered cold resistant. Sugar-leaves exposed to —7°C. remained uninjured, while controls kept alongside them in water, were killed. He found also that in submerged water plants, which wintered above the freezing point, starch was not entirely changed to sugar and that associated with this, such plants were killed by freezing at —2°C. Water plants, however, which are in part exposed to the air, such as *Ranunculus lingua*, lose their starch and withstand temperatures of —7°C. Lastly, the starch sugar change is reversible, so that with warmer weather, on the return of spring, starch reappears, and in this is seen an explanation of the fact that a *sudden* though mild cold snap, after a warm spell in spring is often far more damaging than the deepest cold of mid-winter.

It may be regarded, therefore, as established that sugar exercises a protective action against frost injury. As to how this protective effect came about, whether by preventing the precipitation and dissolving action of concentrated salt solutions upon elements in the colloidal matrix of the protoplasm or by increasing the water-holding power of the system as a whole against ice formation is not clear. Moran found that egg yolk was protected by the addition of sugar from the irreversible effects of exposure to freezing between —7°C. and —11°C.

Certain plants which form and contain great quantities of sugar are notably susceptible to cold, such as the sugar cane and the sugar beet. It is clear, therefore, that the protective action of sugar which accumulates during hardening at low temperature and also incidentally under the influence of water shortage is not the only factor responsible for frost tolerance.

[20]Lidforss. *Die Wintergrüne Flora*, Lund, 1907.

The change of balance resulting in the accumulation of sugar at the expense of starch at low temperatures, which was first thoroughly studied in potatoes by Müller Thurgau in 1882, is probably a typical case of a wider generalisation to the effect that down-grade products of hydrolysis accumulate at the expense of up-grade products of condensation—simpler down-grade products at the expense of more complex up-grade products. It has been found, for instance, by Harvey that during the process of hardening by exposure to low temperatures above the freezing point, there is an accumulation of the cleavage or hydrolysis products of protein.[21]

INCREASE IN WATER HOLDING CAPACITY OF CELL COLLOIDS.

In view of the various aspects of this interesting problem of frost resistance, which we have so far reviewed, it is rather surprising to find that very few attempts have been made actually to measure the amount of ice formed in tissue at various temperatures below the freezing point. I need not here go into the methods and difficulties of doing this with accuracy, but after reminding you that Plank found only 76 per cent. of the water in meat frozen at —7°C.[22] I will bring this lecture to a conclusion by briefly describing the investigations of Hooker, Rosa and Martin.

Rosa comparing 100 grams of hardened leaves with 100 grams of tender leaves found a greater absolute amount of water remaining unfrozen at different temperatures in the hardened leaves, in spite of the fact that the total amount of water in a hundred grams of hardened leaves is less to begin with. The following are some of his figures for grams of water unfrozen in 100 grams of leaf.[23]

	hardened	tender
—3°C.	60 grams	35 grams
—4°C.	43 ,,	22 ,,
—5°C.	35 ,,	16 ,,
—6°C.	30 ,,	14 ,,

The increased water-retaining capacity of the system after hardening, thus indicated by these and other similar results of measurements of the actual amounts of ice formed, are most probably to be attributed to increased inhibitional or capillary forces in the colloids. For instance in support of this view Hooker obtained some evidence by first killing and air drying hardened and unhardened tissues, and then exposing the material thus obtained to definite water vapour pressures over sulphuric acid. They found that, in equilibrium with any given water vapour pressure, the hardened material held more water than the unhardened.[24]

Chemical analyses carried out in connection with the work of these two authors appear to indicate that this increased water holding power is associated

[21]Harvey. *Loc. Cit.*
[22]Plank, R. *Z. ges. Kalte-Ind.*, 32, 1925.
[23]Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 1921.
[24]Hooker, H D. *Proc. Am. Soc. Hort. Sci.*, 1920.

with the accumulation of water soluble polysaccharides of the pentosan class—the class which give cacti their great water holding power.[25]

This discovery of the association between frost tolerance and the water holding capacity of the cell colloids, has recently been applied in an ingenious way to distinguish between winter hardy and tender wheats—a very important thing to be able to do without waiting for test winters when new varieties are being bred. Martin simply submitted the tissues to a standard hydraulic pressure and measured the juice pressed out. He concluded that the most important character influencing hardness is the ability to build up a high inhibitional pressure of the cell colloids during hardening.[26]

Summary of Factors Determining Frost Injury in Plants.

In these few examples we have touched briefly on a few of the outstanding factors which may enter into the question of injury, or the occurrence of irreversible changes when living tissues are frozen. There is the speed of cooling, affecting the manner in which ice is formed ; the temperature reached and the water-holding power of the cell systems, affecting the amount of ice formed ; the influence of increased salt concentration upon the colloidal state of the protoplasm ; the time of exposure, affecting the extent of slow changes in the desiccated colloids. To these variants must undoubtedly be added the specific nature of the colloidal constituents, and of the salts of different tissues. Such then are the possibilities which are to be subjected to detailed quantitative investigation when any specific case of freezing injury or more broadly, of non-reversibility in freezing-thawing cycles are in question.

Our study of plants in the laboratory of Nature has led us to see that though low temperature and freezing may appear the obvious method of retarding changes in stored food products, closer consideration has indicated that there are many complications both in living and post-mortem systems. These complications form the interest and field of the biologist and I hope that to-night, as an introduction to my two following lectures, I have been able to give you some slight acquaintance with their nature.

[25]Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 1920.
[26]Martin, J. H. *Loc. Cit.*

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, January 28. . Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Mains Testing," opened by Mr. F. C. Raphael.
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."
At Bristol. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture).
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin." Lecture XI : "Other Tectonic Mountains."
University of London, at King's College, Strand, W.C. 5.30 p.m. Major-General Sir Frederick Maurice, "Allenby's Campaign in Palestine." (Lecture III).
At University College, Gower Street, W.C. 2 p.m. Prof. H. E. Butler, "The Rome of Virgil and Horace."
At University College, Gower Street, W.C. 5 p.m. Mr. G. P. Crowden, "Fatigue." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Prof. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Mr. C. H. Collins Baker, "The Dutch School of Landscape Painting."

TUESDAY, JANUARY 29..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Prof. J. L. Myres, Presidential Address.
Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Messrs. J. H. Hyde and H. R. Lintern, "The Vibrations of Roads and Structures." (further discussion).
Electrical Association for Women, at 15, Savoy Street, Strand, W.C. 7 p.m. Mr. F. W. Purse, "How Electricity is generated at West Ham."
Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."
At the North British Station Hotel, Edinburgh. 7 p.m. Mr. E. Seddon, "Recent Extensions to Portobello Power Station."
Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. B. P. Deedding, "Errors in Testing Bulb Supply by Random Selection."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species."
University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. P. Dearmer, "Dutch Painting." (Lecture III).
At King's College, Strand, W.C. 5.30 p.m. Prof. R. W. Seton-Watson, "The Eastern Question." Lecture III: "The Rise of Nationality and the Revolutionary Wars."
At University College, Gower Street, W.C. 5.30 p.m. (Lecture I) of Course on "The Current Work of the Biometric and Eugenics Laboratories."

WEDNESDAY, JANUARY 30..British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. The Very Rev. W. R. Inge, D.D., "Plotinus."
Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. H. G. Cousins, "Design and Construction of Victoria House."
Swiney Lecture, at the Royal College of Science, South Kensington, S.W. 5.30 p.m. Dr. R. Campbell, "Mountains and their Origin." Lecture XII: "Subsequent or Relict Mountains."
United Service Institution, Whitehall, S.W. 3 p.m. Sir Norman Leslie, Bt., "The Mercantile Marine in a Future War."
University of London, at King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "Contemporary Russian Literature, 1917-1928." Lecture III: "Solitary Poets: Khlebnikov, Pasternak, Isvetaveva."
At King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History." Lecture III: Mr. A. T. Bolton, "The English House (later periods)."
At the London School of Economics, Houghton Street, W.C. Mr. Ernest F. Bean, "Some Uses of the Sundstrand Machines."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture III).
At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La lirica del Paradiso." (Lecture II).
At University College, Gower Street, W.C. 5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Mr. W. E. Doubleday, "The History of the Public Library Movement, to the end of the 19th Century."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Tancred Borenius, 'Rembrandt and Italian Art."
At University College, Gower Street, W.C. 5.30 p.m. Mr. J. H. Helweg, "The Renaissance Period in Danish History and Literature." (Lecture III).

THURSDAY, JANUARY 31..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. W. S. Farren, "Monoplane or Biplane?"
Antiquaries, Society of, Burlington House, W. 8.30 p.m.
Linnean Society, Burlington House, W. 5 p.m.
Mechanical Engineers, Institution of, at the Engineers' Club, Manchester. 7.15 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays."
University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Mr. H. V. Nanchester, "Indian Architecture."
At King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "Czechoslovakia." Lecture III. "The Great War and Czechoslovak Independence."
At King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Meyendorff, "Public Finance in Eastern Europe." (Lecture II).
(Kings College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." Lecture II: "Chroniclers and Historians."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. Andrew McCance, "Some Applications of Physical Chemistry to Steel Manufacture." (Lecture IV).
At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture II).
At University College, Gower Street, W.C. 5 p.m. Dr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture III).
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. F. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450-850." (Lecture I).
At University College, Gower Street, W.C. 5.30 p.m. Prof. A. F. Pollard, "Cardinal Wolsey." (Lecture IV).
Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. Maurice W. Brockwell, "Rembrandt as a Painter."

FRIDAY, FEBRUARY 1..Chemical Industry, Society of, at Milton Hall, Deansgate, Manchester. 7.30 p.m. Dr. F. Challenger, "The Sulphur Compounds of Shale Oil and Petroleum."
Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. J. L. Carr, "Recent Developments in Electricity Meters."
Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. T. H. Cross, "Notes on Road Construction."
Mechanical Engineers, Institution of, Great George Street, S.W. 6 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture).
At the Chamber of Commerce, Birmingham. 7.30 p.m. Mr. E. H. Pease, "Recent Developments in Multiple Drilling and Tapping."
Philological Society, at University College, Gower Street W.C. 5.30 p.m. Prof. V. G. Childe, "Philology and Archæology."
Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. J. L. Myres, "Geometrical Art."
University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. J. H. Rose, "Ibrahim Pasha in Morea and the Battle of Navarino."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. C. E. R. Sherrington, "The Steam Railways and the Localising of Industry in the Nineteenth Century."
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture III).

SATURDAY, FEBRUARY 2..L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "The Ancient Egyptian Potter and his Clay."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Cammaerts, "Flemish and Belgian Art—Genre Painting."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 4th, at 8 p.m. (Cantor Lecture.) C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, "The Treatment of Coal." (Lecture III.)

WEDNESDAY, FEBRUARY 6th, at 8 p.m. (Ordinary Meeting.) Sir J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., "The Vibrations of Railway Bridges: an Example of Co-operative Research." (Trueman Wood Lecture.) SIR GEORGE SUTTON, Bt., Chairman of the Council, will preside.

FRIDAY, FEBRUARY 8th, at 4.30 p.m. (Indian Section.) CAPTAIN SIR E. J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., "The History of the Indian Marine." VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, late Commander-in-Chief, East Indies Squadron, will preside. Tea and coffee will be served in the library from 4 p.m.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JANUARY 23rd, 1929. THE RIGHT HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D., F.R.S., P.S.A., in the Chair.

A paper entitled "Museums and Education" was read by SIR HENRY A. MIERS, D.Sc., LL.D., F.R.S. The paper and discussion will be published in the *Journal* on February 22nd.

CANTOR LECTURES.

MONDAY, JANUARY 28th, 1929. DR. R. LESSING, Ph.D., F.C.S., in the Chair. DR. C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the second of his course of three lectures on "The Treatment of Coal."

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By FRANKLIN KIDD, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

LECTURE II. REFRIGERATION AND FRUIT.

(Delivered November 19th, 1928).

RETROSPECT.

In considering the subject of Refrigeration as applied to the preservation of food stuffs, we set out by drawing a distinction between two possible methods of approach, and indicated that a certain fundamental antithesis in motive must exist between those whose life work was directed along one or other of these two lines—between those whose object is to develop and make a success of the industries of food production, transport and storage, and those whose interest lies in obtaining a deeper knowledge of the nature of things.

We next passed to consider the great diversity of food stuffs, plant and animal; living and post-mortem; eggs, fish, meats and poultry; fruits, green leaves, resting organs and growing points of plants. Considerable diversity also exists in the ways in which cold is applied in practice, and in the varying limitations imposed on ideal procedure when food stuffs are stored and handled under commercial conditions.

Following out the practical line of approach we had to contemplate, therefore, what would amount to a text-book taking particular products, producing centres and trade routes in turn.

We took then the other line of approach and I gave you a rapid survey of what can be learnt about the effects of low temperature upon biological material from a study of the behaviour of plants in nature.

We considered particularly the resistance or otherwise of plants to freezing temperatures—their capacity to survive severe frosts. Great differences exist between different species of plants in this respect, and certain plants which, if brought suddenly into the cold, are unable to tolerate the least touch of frost, can nevertheless be educated to a considerable degree of frost tolerance. We found that young tissues were often far more tolerant of freezing temperatures than old tissues, and that within any species there were racial variants as regards frost tolerance. We saw also that there was a rhythm of rest and activity in plants, and that in the resting stage cold-tolerance

was often increased to a most striking extent. Finally we found that the onset of rest and the "education" of plants to cold tolerance could be artificially brought about.

We examined next how and where ice was formed in plant tissues and we saw that the difference between cold resistant and non-resistant plants, or between hardened and non-hardened plants, or between the destruction of the delicate organisation of the living protoplasm and its survival, depended on a number of factors; for example, the effects of the concentrated salt solutions formed when pure water is withdrawn from the living system in the formation of ice, the accumulation of such substances as sugar in the tissues, and finally the variable water holding capacity of the colloidal or jelly-like constituents of the living cells.

In the course of this survey of the effect of freezing temperatures upon living plants, it must have been obvious to you, though I did not stress it, that we were on the same ground as in studying the effects of freezing upon post-mortem tissues such as meats—with this advantage, that in death we have a highly sensitive and easily observed indicator of irreversible disorganisation.

THE APPLE—ITS PROPERTIES AND BEHAVIOUR.

We are to turn now to one food product in particular, namely, the apple. The apple, the orange and the banana are three of the world's principal fruits of commerce to-day. I shall deal with the apple, because by devoting most of our time to this one fruit, I shall be able to illustrate to you more fully what is involved in a study of the nature and behaviour of a plant food-product, and secondly how such a study yields results of practical utility in regard to the storage of the product under refrigeration.

STRUCTURE, CHEMICAL CONSTITUTION AND LIFE-HISTORY.

What then is an apple? An apple is the much enlarged stalk which once carried the blossom. Its growth has dated from the pollination of the flower. When we come to know it as an article of commerce, it has passed through its youth, has become mature, has separated from its parent and is already on the downward path of old age or senescence. The course of change in form during growth is shown diagramatically in figure 1 which is taken from a paper by Kraus.[17]

As regards the percentage content of various substances present in the fruit at various stages in its life-history, the following is a brief summary of what we find.[18]

The protein content, which is an index of the amount of living protoplasm, reaches a maximum very early. It decreases during growth, but remains

[17] Kraus, E. J. *Oreg. Agric. Coll. Exper. Stat. Bul.*, 1, 1913; 135, 1916; 138, 1916.
[18] Haynes, D. et al. *Ann. of Bot.*, 1925-1928; *Ann. Reports, Food Investigation Board*, 1919-27.

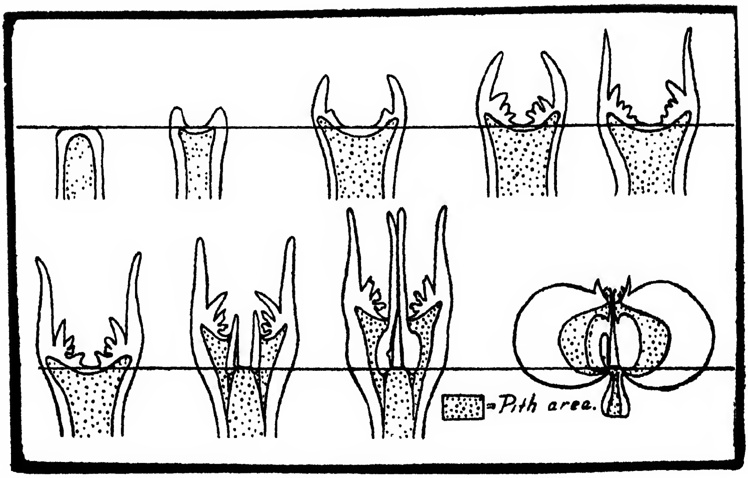

FIG. 1.—Diagram showing development of an apple. Not drawn to scale. (After E. J. Kraus)

practically constant during storage. The acid content also reaches a maximum at an early date and decreases during growth. The acid content, however, continues to decrease during storage.

The starch content is at a maximum about the middle of the growth period or a little later. There is none in the very young fruit and it has all disappeared again very soon after gathering. The disappearance of starch after it has been formed is due to its transformation into sugars.

There are two main kinds of sugar, (1) cane sugar, a more complex sugar which is chiefly responsible for sweetness, and (2) hexose sugars, which are simpler sugars, principally glucose and laevulose. The percentage content of the apple as regard sugars increases throughout the period of growth on the tree. Cane sugar is at a maximum about the time of maturity and subsequently decreases after gathering by transformation into hexose sugars.

The percentage content of hexose sugars continues to increase during storage, especially if there is much loss of water by evaporation.

You will observe that the flux of change with age may be broadly described as a succession in which complex substances are first formed and later again resolved.

The cell walls bounding the individual living cells of the tissue are intimately concerned in this flux of change. They are built up of cellulose (a substance closely allied to starch) and of substances in the pectin class. After maturation a continuous process of degradation goes on in which these solid substances of the cell walls are resolved into their simpler soluble components. It is this process which gives rise to the softening of the fruit.

THE RESPIRATORY SYSTEM.

A very important feature of the apple is the skin. The skin is relatively impervious to water and gas and becomes increasingly so as the apple matures. It is, however, at all times perforated by minute openings which, in a mature apple, are generally visible to the naked eye as tiny specks which occur more thickly round the " eye " or flower end of the fruit than round the stem end.

Throughout the flesh, between the living cells, is a network of fine air spaces communicating with the external atmosphere through these pores. It is the existence of this fine mesh-work of air channels which gives a slice of apple, when held up to the light, its white opaque appearance. If the air is driven out of these passages and its place taken by liquid, the flesh of the apple becomes translucent. Just the same thing happens as when blotting paper is dipped into water. There is a disease of the apple called water core, and it is a characteristic feature of this disease that the fine mesh-work of intercellular air spaces is filled with fluid so that the flesh becomes translucent.

It is important to note that, in the early stages of growth, the fruit is open to the core from the flower end, and that in some varieties, even when the apple is fully developed, there is still an open way from the core to the exterior (fig. 1).

The impervious skin with its openings, the fine network of intercellular air spaces, and the core cavity which is sometimes open to the exterior, constitute the system by which the oxygen requirements of the living cells are met, and the means by which carbon dioxide given off by each living cell escapes. It is mainly through this system of air channels, also, that water vapour passes to the exterior and the drying and final shrivelling of the fruit result.

When we speak, then, of the respiration of an apple, we mean the consumption of oxygen and the giving off of carbon dioxide by each living cell, with a concomitant evolution of heat and destruction of such substance as sugars and acids in the apple.

The activity of respiration is generally measured in terms of the volume of carbon dioxide given off by a standard weight of fruit in a given time, for example, as cubic feet per ton per day or cubic centimetres per kilogram per hour.

The consumption of oxygen on a volume basis is under most conditions approximately equal to the production of carbon dioxide.

RESPIRATORY ACTIVITY AND AGE.

The activity of this process of respiration in the apple is the next important point for us to consider. It is important in regard to storage because of the heat production associated with it, and because of the modification in the atmosphere of the store which it brings about. It is important also as a primary index of the condition of the fruit, as it changes with time, and its qualities alter as a food product. There are wide differences in respiratory activity

associated with the age of the fruit, the temperature, the oxygen supply and pre-storage factors of race and nutrition.

With regard to age, we find that the respiratory activity of the mature apple is only about a tenth of that of the young fruit early in its growth. There is a steady decrease in activity from the earliest stages onwards. At maturity a change occurs. Respiratory activity rises more or less suddenly to about double its value before the change. This change marks what I have called the climacteric in the life history of the fruit, and is associated with the development of flavour.[29] Subsequent to this change, respiratory activity again decreases in a regular manner until the tissues die. Death is marked by an increase in activity of short duration and then a rapid falling off to zero. Death and cessation of respiratory activity is not related in any obvious way to exhaustion of the sugar and the acid which form the fuel for the process.

RESPIRATORY ACTIVITY AND TEMPERATURE.

My next figure (Fig. 2) shows you the relation between temperature and respiratory activity.[30] This general relation holds at any stage in the life of the apple. The actual values in the figure refer to the stage of maturity. About 12 cubic feet of carbon dioxide per ton of apples are formed per day at 70°F., as compared with about 2.5 cubic feet per ton per day at a cold storage temperature of 35°F.

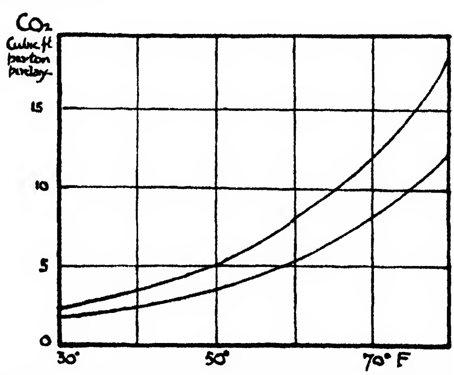

FIG. 2.—Temperature and the rate of carbon dioxide production by mature apples. The two curves indicate the limits between which most varieties under most conditions lie. (After Kidd and West.)

RESPIRATORY ACTIVITY AND OXYGEN SUPPLY.

The relation of the respiratory activity to oxygen supply is complex. At maturity minimum activity is, broadly speaking, with 5 per cent. of oxygen in the external atmosphere, this minimum being about seven-tenths of the normal air value.

[29] Kidd, F., and West, C. *Food Investigation Board, Ann. Report*, 1924.
[30] Kidd, F., and West, C. *Food Investigation Board, Special Report* 20, 1924.

As time passes in storage and as the apple ages, respiratory activity is minimum with progressively higher amounts of oxygen in the external atmosphere until pure air itself containing 21 per cent of oxygen affords the conditions for minimum respiration. At this stage the output of CO_2 will be increased, no matter whether you diminish or whether you augment the amount of oxygen in the atmosphere. With oxygen percentages below those permitting the minimum respiration the character of respiration changes, it becomes less of an oxidation and more of a fermentation. Carbon dioxide is produced without a corresponding uptake of oxygen, as in the fermentation of sugar by yeast.

Respiratory Activity and Race.

Race and nutrition appear to influence respiratory activity throughout the life of the fruit, setting as it were a higher or a lower average pitch. The following, for example, are values found by Gore for the respiratory activity of five different varieties of apples at the time of gathering.[31]

Variety.	*When gathered.*	*Respiratory activity (milligrams* CO_2 *per kilogram-hour at* $32°$ *F)*	
Jefferis	Mid August	6.3	summer apples
Summer Pearmain	Mid August	6.7	
Yellow Bellflower	Early October	5.9	winter apples
Red Permain	Early October	4.3	
Missouri Pippin	Mid November	4.6	

Summer apples, Gore adds, do not keep as well as winter apples and respire more rapidly.

The Self-Heating of Fruit in Bulk.

We have now answered to some extent the query: what is an apple? We know something about its properties and behaviour, and we shall next consider how this knowledge may be important in connection with the storage and transport of the product.

Let me take first the question of heat production. On the basis of a mean value for a number of varieties taken at the time of maturity, it has been calculated that, in the case of an apple cargo from Australia, the heat to be removed in cooling from 70°F. to 35°F. is approximately equal to the total amount of heat subsequently to be removed throughout the voyage, and that the heat being generated by the apples at any time after cooling down is on the average three or four times as great as the heat leaking through the insulated walls from the sea.

These calculations were based on a knowledge of the heat produced in the burning or oxidation of sugar to carbon dioxide and water, which is in effect what occurs in the respiratory process.

[31]Gore, H. C. *U.S. Dept. of Agric., Bur. Chem. Bull.* 142, 1911.

Quite recently the heat given off by apples in storage has been measured by my colleague, Dr. Ezer Griffiths. From Dr. Griffiths' observations it appears that at 20°C. a cubic foot box of apples generates heat at the rate of 0.14 calories per second. Translating this into terms of a ship's hold loading apples, we can say that, assuming an average equipment and a loading temperature of 20°C, something like a tenth of the maximum capacity of the machine is occupied at the outset simply in holding the temperature of the fruit steady, that is, in preventing it rising any higher.[32]

DISASTERS DUE TO SELF-HEATING.

The heat production, consequent on the respiratory activity of fruit, has to be taken into serious consideration in refrigerated transport and storage. As a matter of fact, disasters have occurred in which the power of the refrigerating plant has been insufficient to overcome the heat produced by the material. In this case a vicious circle is established. As the temperature rises so the rate of respiration increases, leading to still greater heat production and a still faster rise in temperature. Under these conditions the insulated walls, which have been so carefully provided, only serve to accelerate this cumulative process, which may result in a total loss. You will realise that the temperature at which the fruit stands when it is loaded into a hold or store must play a determining part in such an extreme case as this, and also that the conditions which will give rise to this vicious cycle occur immediately if there is any breakdown in the machinery producing or distributing refrigeration.

From the following table (after Gore) you will see that the apple is one of the least active of the fruits as regards respiration and heat production. Some of the smaller soft fruits have a far greater respiratory activity, and, as I have already pointed out to you, the activity of the apple itself varies from ten to one as it develops on the tree.

Fruit.	*Respiratory Activity (Milligrams of CO_2 per kilogram hour at* 32°*F.)*
Blackberry	35
Raspberry	24
Black currant	12
Red currant	5
Peach	12
Plum	6
Strawberry	17
Apple	6
Pear	3

[32] Griffiths, E. *Proc. Phys. Soc.*, 40, 1928.

Self Heating and Uneven Temperatures.

The extreme case we have just dealt with introduces one of the outstanding problems in the refrigeration of fruit and vegetable products to-day—the problem of obtaining uniformity of temperature throughout a large cargo. With the increasing volume of commerce in these articles, economy demands the storing and transport of the largest bulk in the minimum space. Thus lower holds 60 x 60 x 15ft. are now used for the overseas transport of apples, and in such holds the stacked apple cases fill all the available space to the roof. While limited to operating on the surface of this self-heating bulk, how far can we maintain an even temperature throughout the whole stack ?

Cargo Temperature Surveys: (1) Australian.

A few years ago an investigation was undertaken by the Food Investigation Board to find out how effective were the various systems of cooling in vogue with regard to securing uniformity of temperature throughout the bulk of a cargo. The survey was carried out on ships bringing apples from Australia. Three-dimensional maps of the temperatures in all parts of the holds during the voyages were obtained by using distance-reading electrical thermometers distributed throughout the cargo and actually inserted into cases of fruit.[33]

The following illustrations (figures 3 and 4) are an example of what was

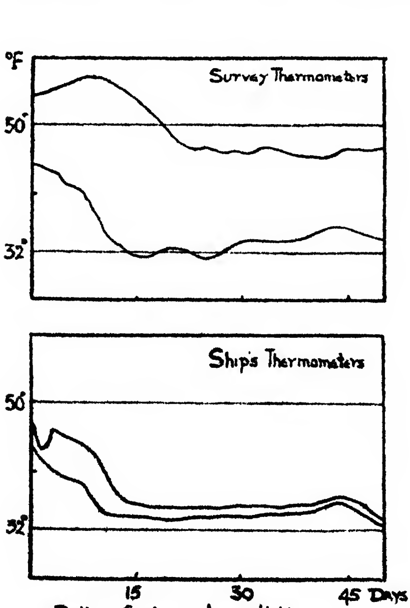

Fig. 3.—Maximum and minimum temperatures in an Australian apple cargo during voyage. (After A. J. Smith.)

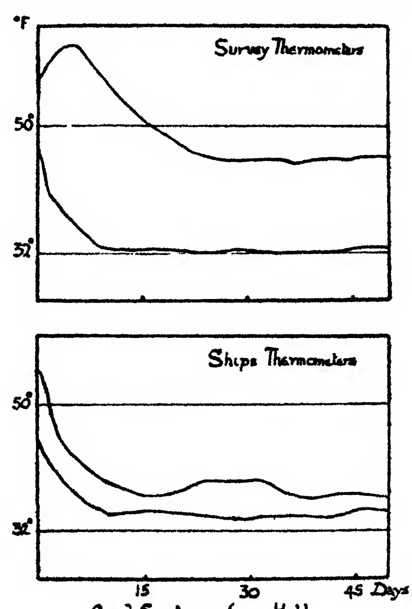

Fig. 4.—Maximum and minimum temperatures in an Australian apple cargo during voyage. (After A. J. Smith.)

[33]*Food Investigation Board, Special Report* 20, 1924; 27, 1926.

discovered. It should be remarked in passing that the ship's thermometers, which are usually situated midway between the sides of the chamber and its centre, tend not to show the extremes of temperature distribution either in the colder or the warmer positions.

The outcome of this investigation was to emphasise three things :—

(1) The striking lack of uniformity of temperature throughout the bulk of the cargo, especially in large holds ; (2) the necessity for powerful fans and rapid air change in the case of the battery system ; (3) and lastly, the general advantage to be gained by cooling as far as possible from the top, and the desirability of providing vertical breaks in the cargo stack.

(ii) SOUTH AFRICAN.

Following these investigations, which were carried out with the co-operation of the shipping companies, some most interesting experiments were made by the scientific staff of the South African Government, again in co-operation with a shipping company.[34]

Within the last decade South Africa has become an important fruit-producing country and a large contributor to the world's sea-borne commerce in fruit. The South African trade is an all-year-round one, oranges during the winter and pears and many varieties of soft fruits during the summer. Accurate control of temperature is of particular importance in the carriage of soft fruits and pears.

In the first place, temperature surveys by distance-reading electrical thermometers were carried out in a small hold with baffled side grids and no forced air circulation. The capacity of this hold was only 6,430 cubic feet and it was only 7ft. 6ins. high. The following temperatures are typical of the distribution found after the first few days :

	Centre.		*Sides.*		
Top	33°F.	42°F.	41°F.	42°F.	38°F.
Middle	35°F.				
Bottom	33°F.	33°F.	34°F.	33°F.	31°F.

The difference from floor to ceiling varied during the voyage, but, except at the centre, persisted to the extent of at least one degree increase per foot of height to the end of the voyage. The specified temperature for the carriage of the fruit was 34°F. As the result of this survey, adjustments in the baffles were made and some improvement in temperature uniformity thereby obtained.

A similar survey was then carried out in a hold fitted with a battery substitute system, sometimes spoken of as the screened-grid and fan system. The principle of this system will be understood by reference to the illustration (figure 5). The results were summarised as follows .—

" There is a progressive rise in temperature across the hold, the fruit at one side being 14°F. hotter than the other. On reversal of the air current the temperature gradient is reversed and the fruit is subject to an 8°F. fluctuation every

[34] *Union of South Africa, Dept. Agric., Science Bull.*, 56, 1926.

4·6 hours. The difference of temperature from floor to roof is of serious magnitude. The extremes of temperature in this one hold were 27°F. and 45°F." A feature of the system which renders equable control of temperature difficult is the unequal exposure of the circulating air to the cold pipes. The air at the forward end has to traverse the maximum length of cold piping before entering the hold through the ports in the screens.

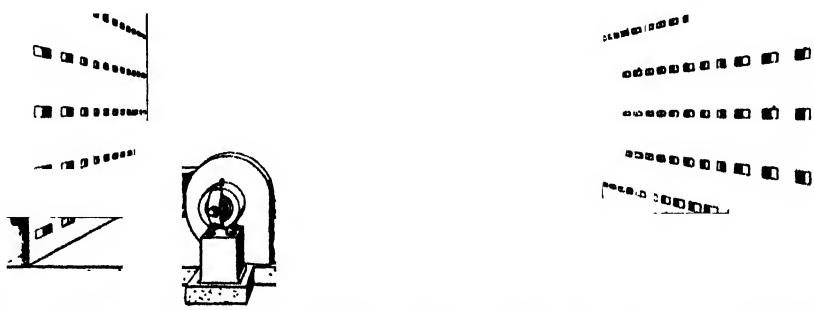

FIG. 5.—Diagram of battery substitute system showing fan, screened grids and ports in the screens. (After Griffiths and Davies.)

Following this survey a modification of the system was introduced and tested by further survey under actual shipping conditions with a full cargo. The ports in the screens were omitted. The air was carried round the sides of the chamber in trunks under the screens, passed thence vertically over the pipes on the walls behind the screens and poured over the top of the screens, being thus delivered at a high level. Improvement was achieved, but the resultant temperatures were still not satisfactorily uniform, owing partly to the fact that the air delivered into the chamber after cooling was still not at a uniform temperature and partly to the fact that on pouring out over the top of the screen the cold air tended to fall.

A further modification was then made. The ports in the screens were again introduced, but, instead of passing the air horizontally across the hold, which is the traditional method both in the screened-grid and in the battery systems, the air of the hold was drawn out on both sides, cooled in its passage over the side grids and then delivered again into the hold by trunks distributed on the roof. By this method the air after cooling was delivered into the hold at a uniform temperature and at points distributed over the top of the cargo. The uniformity of temperature was very appreciably improved, the top and bottom difference being reduced to less than 3°F. at extreme points.

The South African investigators, A. E. Griffiths and R. Davies, who carried out the surveys we have been dealing with, summarise their experience as follows :—

1. Circulation of air is a practical necessity with 'tween deck or lower hold in order to obtain uniform temperature conditions, and this circulation has also very valuable advantages in controlling gas and moisture conditions for a commodity like fruit or eggs.

2. The only sound and reliable system for air circulation is the self-contained battery with sectioning valves. The battery chamber should also be subdivided into two compartments for convenience in thawing off snow deposits, and thawing facilities are essential for fruit ships.

3. Batteries should be in the chambers or holds and not trunked for long distances. A number of small units are in every way preferable to one or two large ones.

4. Air circulation must be adequate; 15 to 20 cubic feet per minute per shipping ton of fruit should be provided, and all fans should be centrifugal multivane type to develop ample flow through closely stowed fruit boxes.

5. Air trunks should be distributed to make the path of the air from delivery to suction through the fruit short, thus avoiding excessive gradient of temperature due to heating up of the air in a long passage through hot fruit.

Delivery over the top of the fruit is strongly recommended and suction should be by a wide trunk around the sides of the hold.

A Bulk-Storage Research Chamber.

There is under construction in this country a large storage chamber to be fitted with special equipment for investigating the various problems connected with the control of temperature, of humidity and of atmospheric composition in the bulk-storage of biological material. I shall not be able to-night to deal with the problems of humidity and atmospheric control, but it is important to realise that these three factors of storage environment are *interdependent variables*. We cannot alter one without affecting the others. It is the interdependence of these variables which, in addition to the complexity introduced by bulk, further complicates the problem. As regards refrigerated stores and ships' holds already in existence, of all sizes and equipped with different types of cooling systems, much may be learned and much improvement effected by the method of survey and adjustment as we have seen.

Temperature and Length of Storage-Life.

From the facts that we have so far examined our interest naturally turns to the question as to the precise extent to which temperature affects the rate of ripening or ageing of fruit in storage. We may again take the apple for the purpose of illustration. In figure 6 is set out a definite quantitative relationship between length of storage life and storage temperature.[35] May I direct your attention to the degree to which relatively small differences in the storage temperature affect the length of storage life. A variation of 1°F. may alter the length of storage life by as much as 10 per cent., while there is very nearly a 100 per cent. difference in effect between a storage temperature of 32°F. and 42°F.

[35] Kidd, F., West, C., and Kidd, M. N. *Food Investigation Board, Special Report* 30, 1927.

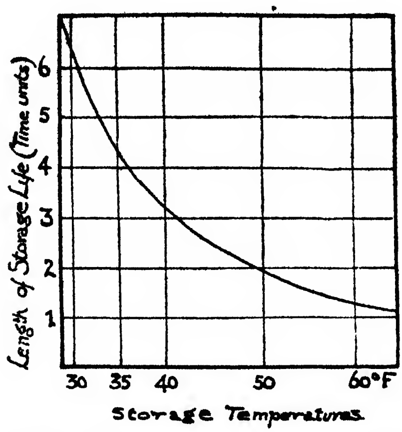

FIG. 6.—(After Kidd, West and Kidd.)

A short explanation of how a general relationship of this sort has been ascertained is of interest. From a limited number of trees, samples, each containing a hundred or so apples, are selected in such a way as to make each sample as nearly identical with every other as possible. A number of these samples are then stored at each of a number of constant temperatures. They are withdrawn at successive intervals and each apple cut and thoroughly examined. From these observations a curve depicting the progress of wastage at each temperature is constructed. One such curve is illustrated in figure 7.[26] The average life of the fruit is the time to 50 per cent. wastage. The commercial life may be defined as the time to 10 per cent. wastage. In this way the storage life at the various storage temperatures can be precisely stated and compared.

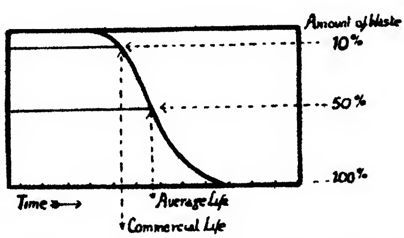

FIG. 7.—Typical curve for the progress of wastage at a constant storage temperature.

BIOLOGICAL VARIATION.

I have dealt with the method employed for determining storage life, because it brings out very clearly an important property of biological material that has to be considered in connection with its storage. I refer to individual variation—the extent to which individual units depart from the mean or average of the

group. Variation will exist in any set of apples not only as regards size, colour, shape, composition, etc., but also as regards the natural term of storage life. From the practical point of view of handling and storing the product, it is of importance to reduce the variation to a minimum. For though two lots of apples may not differ with regard to their average storage life, the lot with the greater range of variation between the individuals has the shorter commercial storage life.

Over-Ripeness and Fungal Rotting.

The end of life in all the cases that we have so far considered is the commencement of rotting arising from fungal infection. Spores of fungal disease are present on the surface of the fruit. For the most part they find their way there before the fruit is gathered. In general, these diseases only attack the fruit when a certain stage of ripeness or over-ripeness is reached. The facts which I have put before you with regard to the relation between temperature and the length of storage life illustrate equally well the relation between temperature and rate of ripening or rate of ageing. Fungal rotting which is not associated with over-ripeness is usually to be traced to surface injuries from rough handling, to physiological disease such as scald, to excessive humidity or to special types of infection.

Low Temperature Breakdown.

Temperature, as we saw in my last lecture, should be expected not only to affect the net speed of the whole complex of changes which underlie ripening and ageing, but also to affect the balance of the various parts in the complex and the composition of the fruit. We found such changes of balance and of chemical composition associated in certain plants with increased capacity to resist frost injury.

The relation between temperature of storage and length of storage life in three different varieties of apple is shown in figure 8. One of the varieties (A) belongs to the class we have already dealt with, in which the length of storage life steadily increases the lower the temperature of the store. In the other two varieties (B and C), you have the surprising result before you, that the length of storage life is only extended by a lowering of temperature down to a certain temperature level. Beyond this, lower temperatures of storage actually shorten the storage life.[36]

In these cases life is ended, not by fungal disease, but by functional breakdown. This breakdown occurs long before the apple shows any signs of over-ripeness. The low temperature has retarded ripening, but it has apparently also upset the balance of the living machine so that complete breakdown and death have occurred.

[36]Kidd, West, and Kidd. *Loc. Cit.*

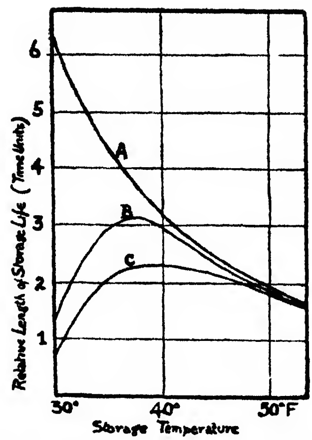

FIG. 8.—Relation between temperature of storage and length of storage life as modified by occurrence of low temperature breakdown in susceptible varieties of apples. Curves C and B are for susceptible varieties; Curve A for a non-susceptible variety. (After Kidd, West and Kidd.)

Breakdown of this sort in apples is known variously as internal browning or internal breakdown, or flesh collapse. It is perhaps better called precisely *Low Temperature Breakdown*, in order to distinguish it from other forms.

Low temperature breakdown is not confined to apples; it is probably common to all fruits in varying degrees. Its visible effects, however, are different in different fruits. Plums, peaches, bananas, oranges, pineapples and tomatoes, all suffer from low temperature breakdown. The experiments of my colleague, Dr. J. Barker with tomatoes may be quoted.[37]

" Experiments with two varieties of tomato, Riverside and Manx Marvel, have shown that they are injuriously affected by storage for more than a short time at temperatures below 50° F. The injury is indicated by failure to develop normal colour and abnormally rapid decay on removal to ordinary temperatures.

Tomatoes kept at 34° F. for four days or less ripened normally at ordinary temperatures, and showed a rate of wastage similar to that of comparable tomatoes which had not been exposed to a low temperature. If, however, the period during which the tomatoes were kept at 34° F. was increased to six or more days, the fruit failed to ripen normally after removal from storage, and an unusually rapid wastage occurred.

Trials with storage temperatures of 34° F., 40° F., 50° F. and 60° F., proved that tomatoes are also injured at 40° F. and 50° F. These results were obtained both with green and fully ripe coloured tomatoes.

It should be noted that the injurious effect of storage at 34° F. is not reflected in the rate of wastage while the fruit is kept at that temperature, but becomes apparent after removal to higher temperatures."

RACE AND STORAGE LIFE.

We have now dealt with two of the forms of wastage which are important in the storage and transport of fruit under refrigeration, namely, over-ripeness

[37] Bark, J. *Food Investigation Board, Ann. Report*, 1927.

associated with fungal rotting, and low temperature breakdown. We have seen how fundamentally important is the temperature factor in regard to both of these. We may next consider the influence of other factors which are under our control, both before storage and during storage.

Let us take first the factor of race. Racial variants within a species are, as I explained last time, fixed and perpetuated in the case of most economic fruits by a process which is essentially nothing more than splitting up the body of the original variant into an indefinite number of racially identical parts. Race variants exhibit very marked differences with regard to inherent keeping quality, rate of ripening and natural term of storage life. The difference between the keeping qualities of different common varieties of apples and pears is so much a matter of common knowledge that one need not enlarge on it here.

Race variants also exhibit, as we have seen, different degrees of susceptibliity to low temperature breakdown.

The practical interest lies in the hope that, with the advent of critical methods of measuring both life duration and susceptibility to low temperature breakdown, progress may be made in the breeding and selection of race variants more suitable than existing ones for the modern requirements of storage and distribution.

Nutrition and Storage Life.

We must not allow ourselves to think that the nutrition of the tree, and of the growing fruit upon it, depends simply upon the soil. From the soil are gathered the requirements of water and mineral salts, including those containing nitrogen. Further, it is upon the physical properties of the soil that the efficiency of the root system of the plant depends. But from the air is gathered the carbon which in various combinations is the major component in the living organism. Finally, from sunlight is gathered the energy which must be absorbed in the process of building up sugars, starches, proteins and such like complex substances from the simpler inorganic food materials upon which the plant subsists.

We class nutritional factors, therefore, under the two main headings—climate and soil. It is not always easy to disentangle their effects.

Climate.

With regard to climate, a good illustration is afforded by the difference between the behaviour of the Yellow Newtown apple from the Pajaro Valley in California and that of the same variety from other regions.[38]

The behaviour of the fruit from Pajaro in cool storage is shown in figure 9. It is definitely susceptible to low temperature breakdown. Elsewhere low temperature breakdown is not known in this variety. The Pajaro Valley

[38] Winkler, A. J. *Journ. Agric. Research*, 24, 1923.

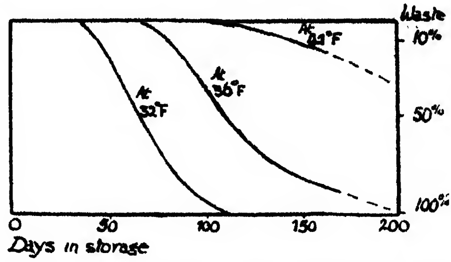

FIG. 9.—Wastage in cold storage from Low Temperature Breakdown in Yellow Newtown apples from the Pajaro Valley district, California Compare the effect of storage at 32° F., 36° F., and 41° F. (After Winkler.)

conditions are characterised by relatively low average temperatures and sunlight, and high humidity.

On a broader basis of comparison we find that New Zealand apples, especially from some regions in the Dominion, are often susceptible to low temperature breakdown. English fruit is also susceptible. The apple crop of the North West of America is not susceptible and can be stored successfully for long periods even at 32°F. The conditions in the North West during the growing season are broadly the reverse of those mentioned above in connection with the Pajaro Valley. They are relatively high temperatures, more sunlight and low humidity.

SOIL.

As to the effect of soil I will give you one example from nearer home. You will notice in figure 10 the great difference in storage life as between fruit grown upon silt soils varying, in the same neighbourhood, from very heavy to very light. These results were obtained by the Food Investigation Board in the course of a joint survey with the Ministry of Agriculture of soil characteristics and fruit keeping quality and chemical composition. This survey has also shown that good keeping quality is associated with the presence of sufficient available potash and phosphoric acid, and the absence of too much nitrogen in the soil.[39]

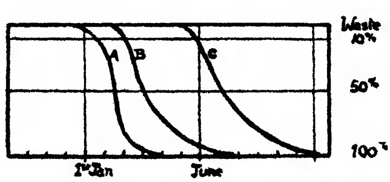

FIG. 10.—Wastage in storage at 34° F. of Bramley's Seedling Apples from (A) light, (B) medium and (C) heavy silt soil. (After Kidd and West.)

[39] Kidd, F., and West, C. *Food Investigation Board, Ann. Report*, 1927.

An elaborate investigation into the effects of climate upon quality has recently been carried out in the United States.[40] The fruit from a hundred different varieties of apples all growing on the same farm has been analysed over a period of six years. Very complete records were kept of sunshine, rainfall and temperature during the growing period of these years. To illustrate the conclusions reached three critical years may be taken, namely, 1923, 1921 and 1924.

In 1923 the total sugar content of the crop was the highest recorded. This year had the most sunshine.

In 1921 the total sugar content ranked second highest for the six years of the investigation. This year had the second highest amount of sunshine and the highest mean summer temperature.

In 1924 the total sugar content was the lowest recorded. This year had the lowest mean summer temperature, and only moderate sunshine.

The 1923 crop was of exceptional high quality as regards colour, size and flavour and stored well. That of 1924 season was markedly inferior in appearance, colour and quality and broke down prematurely in storage.

Maturity and Storage.

We come now to the last of the pre-storage variables with which I shall deal to-day, namely, the stage of maturity at which the fruit is taken from the tree and placed in cool storage. In pursuing this question of maturity we shall meet, and go some way towards understanding, two serious types of wastage which are a source of perennial trouble to the merchant and shipper. I refer to Scald and to a type of breakdown generally known as Jonathan Breakdown, because of its prevalence in the Jonathan variety.

May I recall here the facts that I have put before you as regards the occurrence of a climacteric at the time of maturity, with which is associated a rise in respiratory activity and a concomitant development of flavour and aroma. This climacteric may occur before or after the gathering of the fruit.

Jonathan Breakdown.

With regard to Jonathan Breakdown, Mr. Palmer of the Canadian Experimental Station at Summerland, British Columbia, has, I think, demonstrated clearly that this trouble only occurs if fruit is left too long on the trees. On the basis of his work, a colour standard is now available, by which the proper stage for gathering can be judged as the ground colour of the fruit changes from green to yellow.

Growers are tempted to leave their fruit on the tree too long, in order to get the maximum development of size and of red colour.

This disease, then, is one to which fruit is either definitely predisposed before it enters the store, or to which it is not so predisposed. Predisposed fruit has

[40] Caldwell, J. S. *Journ. Agric. Research,* 36, 1928.

a short life ending in breakdown, sometimes so short that it may even breakdown before it enters the store. With regard to storage temperature, predisposed fruit shows the usual relationship, in that its storage life is prolonged in cold storage. But even so, predisposed fruit cannot compare in length of life with fruit which has not been predisposed.

At this point interesting speculations arise. Is the predisposition to breakdown associated with the occurrence of the climacteric *before* gathering and taking to cool storage. Are the volatile products which develop at the climacteric in any way toxic ? May they, if formed in excess of tolerance, so far affect the living machine as to shorten its natural term of life ?

To answer these questions fully will require further research, and time also, for the simple reason that we get but one crop of apples a year. Their practical importance is obvious.

A recent observation made in connection with banana ripening is suggestive in relation to the possible effects of volatile products given off during ripening. In the experimental chambers of the United Fruit Company at Boston, fruit under test was consistently found to ripen quicker in one of the rooms. Exploration showed that this room was the most gas tight, and experimental work has now been started to ascertain whether ripening is not definitely accelerated by the volatile products of the fruit itself.[41]

APPLE SCALD.

The last topic to be dealt with to-night is apple scald.

Apple scald was at one time estimated to cause greater losses in the United States than all other storage diseases combined. It consists of a browning of the skin without any softening or browning of the flesh. Fungal rotting usually follows it. This disease also is to be considered in close connection with maturity and the phenomenon of the climacteric. An outstanding fact about it is that restricted ventilation in storage greatly increases its prevalence. This fact was first established by the experiments of Messrs. Brooks, Cooley and Fisher in the U.S.A.[42] From their discovery these investigators proceeded to an application of the greatest practical importance. It was argued by them that, if ventilation prevented scald, scald should be due to an accumulation of volatile products. Hence, if these products could be absorbed on some material placed round the fruit in store, scald should be prevented.

Many substances were tested and in the end there emerged the oiled apple-wrapper of commerce to-day. This is a wrapper containing approximately 15 per cent. of odourless mineral oil. Its effectiveness in preventing scald is remarkable. A modification of the oiled wrapper is the oiled paper-straw, or oiled shredded paper, which is used as packing material in barrels or boxes.

[41]Committee of Direction of Fruit Marketing, Brisbane. *Official Report of Mr. W. Ranger*, 1928.

[42]Brooks, C., Cooley, J. S., and Fisher, D. F. *Journal Agric. Res.*, 1917, 1918, 1919, 1920, 1923, 1924, etc.

The next important point to observe is that fruit can be predisposed to scald. The effective causal conditions may, apparently, cause a weakening of the living tissue of the skin and a shortening of its natural term of life. It has been found, for instance, that the preventive action of oiled papers occurs during the earlier days in storage, while the fruit is still to all appearance sound. If the wrappers are removed after this, scald is still prevented. Conversely, if the apples are left unwrapped during this early period, but wrapped later on, while still apparently sound, scald is not prevented.

Once fruit has become predisposed, the disease develops more rapidly the higher the temperature. For this reason predisposed fruit taken from cold store will often scald very rapidly.

With so much established, what then are the facts with regard to the effect of the maturity of the fruit at the time it is taken into close pack in storage. Briefly it appears that immature fruit brought into store (i.e., presumably before the climacteric) scalds severely, but if left out in the open for a time (i.e. presumably till the climacteric is passed) and then brought into store, much less scald develops.

VOLATILE AUTOTOXINS AS A FACTOR IN STORAGE.

It appears possible from what we have seen that volatile autotoxins may be the primary cause both of Scald and Jonathan Breakdown. The occurrence of critical concentrations of these substances in the tissues will depend upon at least three variables, i.e., the stage of maturity, ventilation and temperature. A large field for investigation is opened up here. We have to-day dealt only with the apple, but even in the case of the apple practically nothing of a precise and quantitative nature is known with regard to the nature of the flavour-giving and aroma-giving products: their development in relation to age, race, nutrition and temperature: their specific toxicity in causing breakdown, in predisposing to earlier death, or in predisposing to susceptibility to fungal attack.

Further information on these points would be important, not only from the point of avoiding waste, but also from the point of view of serving the consumer with fruit of the highest flavour and quality.

NOTES ON BOOKS.

THE A.B.C. OF FLIGHT. By W. Laurence Le Page. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. 7s. 6d. net.

"The A.B.C. of Flight" was given to the reviewer as a sort of Christmas holiday task, and a very pleasant and instructive one it proved to be, as the author has successfully contrived to get much useful information, in a form readily assimilable by the average person, into a small space.

Mr. Le Page is well known in aeronautical circles in this country and has a really wide experience, which well qualifies him to treat his subject deeply and in considerable detail. This, happily for the average reader, he does not do, but ably shows in simple language that the behaviour of an aeroplane is quite in accordance with natural laws, and that such can be explained without the use of complex formulæ.

The first chapters give an exposition of the main principles of aerodynamics that are required to explain the reasons for the general lay-out of a modern aeroplane as well as those governing its behaviour in the air. Then follow some general but useful particulars showing how machines are constructed and what materials are used.

The process of learning to fly is very fully and clearly dealt with and, finally, this excellent little work is brought to a close with a chapter on the aero-engine and its major accessories.

Mr. Le Page writes mainly from the standpoint of American practice, but this in no way detracts from the value of his work, as divergence is not considerable. Without doubt, all interested in aircraft, including pilots and would-be pilots, can and should take an opportunity of reading this book.

W.S.

PROBLEMS OF INSTINCT AND INTELLIGENCE. By Major R. W. G. Hingston, M.C. London: Edward Arnold and Co. 10*s*. 6*d*. net.

What is instinct? What is intelligence? Major Hingston prudently abstains from defining them, for, as he says, though many good definitions have been given not one of them is entirely satisfactory. In spite of this, however, every one knows in a general sort of way the difference between the two: instinct works blindly and mechanically; intelligence implies conscious knowledge—a recognition of the relation between cause and effect.

To what extent are animals merely machines? In investigating this problem in the book before us, Major Hingston has restricted himself to the study of insects, because their instincts are so infinitely varied and because they solve many complicated problems in the most perfect way. In doing this, are they nothing but automata? Henri Fabre, who devoted a lifetime to the study of insect life, denied them anything more than an unconscious prompting that has no choice of action. When an insect is carrying out its ordinary avocations, when a bee builds a honey cell with mathematical precision or a spider spins a web with a speed and skill that no human being could rival, it is no doubt actuated purely by instinct; but what happens when an insect is faced by accidents outside its normal experience? Major Hingston made numerous experiments and observations to test them. For instance, he found a pair of beetles (*Gymnopleurus miliaris*) engaged in their usual task of rolling a pellet of dung: "I cut it in half. A terrible calamity! The beetles examine it, survey the two hemispheres. Then they gather the halves together, and press them again into a ball. I cut the ball into four quarters. A still bigger catastrophe! The beetles mould them together again. I alter the shape of their perfect sphere, make one into a cube, flatten another into a disc. It is marvellous to see the beetles' appreciation. I cannot here go into all the details, but they turn both my cube and disc back into the perfect sphere."

Here is another case. "*Myrmecocystus setipes* is a powerful ant. . It had made a nest on the side of a bank. The ejected earth ran down from it in a shoot, like a landslip on the face of a hill. The shoot was very steep and crumbling, and as

each ant carried out its load, it slipped on the loose material and tumbled down to the bottom of the slope. The ants, however, refused to be defeated. After some days of slipping and falling they managed to devise an ingenious plan of getting over this serious difficulty. They assigned to one particular ant the duty of consolidating and hardening the ground. This ant set about collecting pebbles which it found near the foot of the shoot. These pebbles it carried up the shoot and spread them out in the form of a platform at the very top of the shoot, that is, just outside the mouth of the nest.

"This was tremendous labour for one ant. The carrying of the pebbles up the slippery shoot was a task that lasted several days. It required all the labourer's strength, and caused it innumerable falls. It was interesting to see selection at work. The ant never took the first pebble that offered. Several were examined, picked up and tested, until one was met with that fitted the job. Moreover, it did not place its pebbles haphazard; it carefully found a suitable spot for the fitting of each load. The final result was a platform of pebbles on which the excavators walked easily, and no more of them fell down the slope. . . .

"I can no more deny intelligence to this act than I can to a man who builds a parapet to prevent people tumbling down a hill."

On another occasion Major Hingston observed a case where a wasp (*Eumenes dimidiatipennis*) had deliberately planned out the whole of her nest before she built it. "One morning, in a deserted house, I happened to see on a whitewashed wall an example of this mason's work. The wasp had completed two of her cells and was about to commence the third. But here is the point which literally amazed me. In addition to the two completed chambers, the wasp had mapped out the scheme of architecture for all the subsequent cells of her nest. Before me on the wall was a definite plan, a mapping out of the final structure, made, I have no doubt, for the same purpose that the human architect maps out a house. . . . . At the very commencement of her labour she had pre-arranged for the whole work. This, I am confident, implies intelligence."

Major Hingston has for seventeen years been a careful observer of animal life in the jungles of the Oriental forests; he has written a book of absorbing interest to all naturalists, and we think that few will be found to maintain that all the actions of the insects which he describes can be accounted for by blind instinct.

EXACT COLOUR MATCHING AND SPECIFYING. By L. Blin Desbleds. Technological & Industrial Service, 41, Avenue Gambetta, Paris. Price 4*s*.

This short and simply written book deals with the principles of colorimetry and the application of colorimetric measurement to the work of the dyer and colourist. The underlying theory is explained very clearly and in comparatively non-technical language in the first four chapters of the book. Chapter V is devoted to a description of colour measurement by means of the Toussaint photo-electric colorimeter. This is the only instrument described, and unfortunately some misleading statements are made as regards important properties of the photo-electric cell. In the first place it is stated (p.54) that "within the range of use of the apparatus, there is exact proportionality between the light energy acting on the potassium and the change in the intensity of the current in the galvanometer circuit." Later, on p.83, the astonishing statement is made that "the photo-electric cell . . . always reacts in a manner which is exactly proportional to the light energy, *whatever the coloration*, acting upon it." (The italics are the reviewer's). The relative response of the eye to light of different colours is treated at some length in Chapter VIII, but in spite of this the mean of the reflection factors of a coloured surface, measured

at the six wave-lengths, 400, 450, 530, 580, 620 and 700mμ is taken as a measure of the integral reflection factor of the surface, no attention being paid, apparently, to the various visibility factors of lights of these different colours.

From the point of view of the practical dyer, the chapters on colour matching curves and on the fixing of tolerances in colour matching are of the greatest direct importance. The use of colour curves in the correction of mixtures of dyes and in the pre-determination of the mixture required for the production of a specified colour is explained in the final chapters, and these should be of great value to all interested in the subject of dyeing. The printing and production are not as good as could be desired.

J.W.T.W.

GENERAL NOTE.

INTERNATIONAL CONGRESS ON COMMERCIAL EDUCATION.—An International Congress on Commercial Education is to be held in Amsterdam, from the 2nd to the 5th September, 1929. This is being organised by the Dutch National Association for Commercial Education, under the auspices of the International Association for Commercial Education. Business men, educational authorities and governments of about ten countries, including Great Britain, France, Germany, Denmark and China, have promised to send representatives. The task of organising British representation was entrusted to a Committee appointed at a meeting held in London, on November 9th, 1928, at which over thirty members of prominent British organisations connected with commercial education took part. The undermentioned have expressed the hope that Great Britain will be adequately represented at the Congress: The Right Hon. Lord Eustace Percy, The Right Hon. the Lord Mayor of London, Sir John Kynaston Studd, The Right Hon. Lord Southwark, and Sir George Sutton, Bt., Chairman of the Council of the Royal Society of Arts. Those interested in the matter are invited to apply for further information to the Hon. Secretary of the Committee for the Organisation of British Representation, Mr. N. Skene Smith, 5, Onslow Gardens, Wallington, Surrey.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 4..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Business Meeting.

Automobile Engineers, Institution of, at the Merchant Venturers' Technical College, Bristol. 6.45 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. Dr. A. E. Dunstan, "Petroleum as a Source of Synthetic Material."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. W. R. Rawlings, "Earthing and the Safety of the Public."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. A. Kirkwood Dodds, Presidential Address, "Berwick's Bridges."

Farmers' Club, at the Royal Society of Arts, Adelphi, W.C. 4 p.m. Mr. W. P. Seabrook, "The Economic Side of Fruit Growing."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. J. A. Steers, "The Great Barrier Reef Expedition" (Preliminary Account).

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. H. J. Vaughan, "The Significance of the Timber Merchant in Estate Forestry."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Mr. Philip J. Le Riche, "Scientific Proofs of a Universal Deluge."

University of London, at University College, Gower Street, W.C. 2 p.m. Prof. Edmund G. Gardner, "Dante's Italy."

4.30 p.m. Mr. A. M. Hind, "Rembrandt and other Dutch Etchers and Draughtsmen."

5 p.m. Dr. W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture I.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture IV.)

TUESDAY, FEBRUARY 5..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. N. Colam, "The Regirdering of the Railway Bridge over the Kistna River Madras and Southern Mahratta Railway: Fourteen spans of 150 feet."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

At Lamb's Restaurant, Dundee. 7.30 p.m. Discussion on "Earthed versus Insulated Systems."
At University College, Nottingham. 6.45 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."
Goldsmiths' Hall, Foster Lane, E.C. 7 p.m. Sir Lawrence Weaver, "Art, Industry and Salesmanship."
Hellenic Studies, Scoiety for the Promotion of, Burlington House, W. 5 p.m. Mr. A. H. M. Jones, "Excavations at Jerash (Gerasa) by the British School of Archaeology at Jerusalem and Yale University."
Transport, Institute of, at the Society of Arts Hall, George Street, Edinburgh. 7.30 p.m. Mr. A. H. Roberts, "Discharging of Grain Cargoes at Ports with special reference to the Port of Leith."
At the University, Bristol. 5.40 p.m. Mr. A. S. Quartermaine, "The Relation of Civil Engineering to Transport Problems."
Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.
University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture IV.)
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. A. Meyendorff, "The Social Transformation of Eastern Europe."
At University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. Karl Pearson, "The Current Work of the Biometric and Eugenics Laboratories." (Lecture II.)
8.15 p.m. Miss E. Jefferies Davis, "Historical Factors of the Problem of London Traffic." (Lecture I.)

WEDNESDAY, FEBRUARY 6. .Analysts, Society of Public, Burlington House, W. 8 p.m. 1. Dr. T. P. Hilditch and Eveline E. Jones, M.Sc., "The Fatty Acids and Component Glycerides of some New Zealand Butters." 2. Mr. A. Scott Dodd, "A New Test for Boric Acid and Borates." 3. Mr. B. E. Dixon, "The Determination of Beryllium in Rocks."
British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Mr. E. J Forsdyke, "Minoan Art."
Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Dr. B. Hodgson and Mr. L. S. Harley, "The Development of the Oxide-coated Filament."
Geological Society, Burlington House, W. 5.30 p.m.
Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.
Microscopical Society, 20, Hanover Square, W. Meeting of Biological Section.
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture II.)
University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Kendrick, "English Weavings and Embroideries."
5.30 p.m. Prince D. Soyatopolk Mirsky, "Contemporary Russian Literature." (Lecture IV.)
At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. F. Hutchinson, "Measuring Output in Office Practice (I)."
At University College, Gower Street, W.C. 3 p.m Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture III.)
5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture IV.)
5.30 p.m. Prof. E. Vermeil, "Les Relations Intellectuelles entre la France et l'Allemagne."
5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture I.)
5.30 p.m. Mr. J. Haantjes, "The Dutch Mediaeval Tale of Beatrice."

THURSDAY, FEBRUARY 7 .Chemical Society, Burlington House, W. 8 p.m. 1. Messrs. C. S. Gibson and J. L. Simonsen, "Indian turpentine from Pinus longifolia Roxb. Part V. The oxidation of d-Δ^3-carene with Beckmann's chromic acid mixture." 2. Mr. A. W. Chapman, "A new method for preparing substituted diphenylamines." 3. Messrs. C. S. Gibson, J. D. A. Johnson and B. Levin, "Compounds of the tryparsamide type. Part I. Resolution of N-phenylalanine-4-arsenic acid and of its amide." 4. Messrs. C. S. Gibson and J. D. A. Johnson, "10-Chloro-5:10-dihydrophenarsazine and its derivatives. Part VII. The synthesis of the 1-methyl- and of the 3-methyl-homologues."
Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."
Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Sir William B. Hardy, "Education in Refrigeration."
Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays" (Lecture II.)
University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Mr. T. A. Joyce, "The Architecture of Central and South America." (Lecture IV.)
At King's College, Strand, W.C. 5.30 p.m. Mr. R. Fitzgibbon Young, "Czechoslovakia." (Lecture IV.)
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture III.)
At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture III.)
5 p.m. Dr. R. H. Ing, "The Chemistry of Some Natural Drugs." (Lecture IV.)
5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450—850." (Lecture II.)
5.30 p.m. Prof. Dr. A. F. Pollard, "Cardinal Wolsey." (Lecture V.)
Victoria and Albert Museum, South Kensington, S.W 5.30 p.m. Miss C. J. Hudig, "Dutch Silver."

FRIDAY, FEBRUARY 8 .Chemical Industry, Society of (Chemical Engineering Group), at the Royal Society of Arts, Adelphi, W.C. 8 p.m. Prof. Dr. W. E. Gibbs, "The Role of Surface Energy in Chemical Engineering."
Geologists' Association, at University College, Gower Street, W. 7.30 p.m. Annual General Meeting. Prof. Dr. A. Morley Davies, Presidential Address on "Faunal Migrations since the Cretaceous."
Malacological Society, at University College, Gower Street, W.C. 6 p.m.
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Discussion on "The Profession of the Mechanical Engineer," introduced by Mr. L. A. Legros.
Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. D. J. MacNaughton, "Electro-Deposition."
At the University, St. George's Square, Sheffield. 7.30 p.m. Mr. W. T. Griffiths, "Some Recent Developments in Nickel Metallurgy."
North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Dr. G. W. Todd, "The Prediction of the Properties of Engineering Materials from their Ultimate Structures."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1. Mr. L. F. Stanley, "The Construction and Calibration of a Sensitive Form of Pirani Gauge for the Measurement of High Vacua." 2. Mr. H. C. Webster, "Photographic Measurement of the Relative Intensities of the LL1, LL2, LL2 Lines of Silver." 3. Mr. H. C. Webster, "Spark Satellites of the LL Lines of Silver." 4. Mr. W. A. Benton, Demonstration of a new instrument for the rapid and accurate determination of the specific gravities of solid substances.
Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. C. E. R. Sherrington, "Recent Problems of Rail Transport at Home and Abroad."
Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Paper by Mr. A. C. W. Imcey.
University of London, at King's College, Strand, W.C. 5.30 p.m. Professor P. N. Ure, "The Age of Justinian as viewed by some of his Contemporaries."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. C. E. R. Sherrington, "Railway Electrification and the Redistribution of Industry."
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture IV.)

SATURDAY, FEBRUARY 9. .L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. N. Milligan, "Life Beyond the Low-Tide Mark."
Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. S. Marchant, "Music in Cathedral and Collegiate Churches."

JOURNAL OF THE ROYAL SOCIETY OF ARTS.

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FRIDAY, FEBRUARY 8th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK

WEDNESDAY, FEBRUARY 13th, at 8 p.m. (Ordinary Meeting.) CECIL HOOPER, F.L.S., "The Pollination of Fruit Blossoms in relation to Commercial Fruit Growing" (illustrated by lantern slides). H. V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, will preside.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting in connexion with the Fund for the Preservation of Ancient Cottages will be held in the Hall of the Royal Society of Arts on Wednesday, February 27th, at 3 p.m. THE RT. HON. J. RAMSAY MACDONALD, M.P., will preside.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

THOMAS GRAY MEMORIAL TRUST.

PRIZES FOR THE IMPROVEMENT AND ENCOURAGEMENT OF NAVIGATION.

Under the will of the late Thomas L. Gray, the Royal Society of Arts has been appointed residuary legatee of his estate for the purpose of founding a memorial to his father, the late Thomas Gray, C.B., who was for many years Assistant Secretary to the Board of Trade (Marine Department).

The objects of the Trust are "The advancement of the Science of Navigation and the Scientific and educational interests of the British Mercantile Marine."

The Council now offer the following Prizes :—

PRIZE FOR AN INVENTION.

(i) A Prize of £150 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the years 1928 and 1929.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at their discretion. Competitors must forward their proofs of claim on or before December 31st, 1929, to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

PRIZE FOR AN ESSAY

(ii) A Prize of £50 for an essay on the following subject :—

"You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semicircle, (*b*) the dangerous semicircle, and (*c*) the direct path of the storm's centre."

Competitors must send in their essays not later than December 31st, 1929, to the Secretary, Royal Society of Arts, at the above address.

The essays must be typed or clearly written. They must be sent in under a motto, accompanied by a sealed envelope enclosing the author's name, which must on no account be written on the essay. A breach of this regulation will result in disqualification.

The Judges will be appointed by the Council.

The Council reserve the right of withholding the Prize or of awarding a smaller Prize or Prizes, if in the opinion of the Judges no suitable invention or essay is submitted.

The Council also reserve an option on the copyright of the successful essay.

NINTH ORDINARY MEETING.

WEDNESDAY, JANUARY 30th, 1929. JAMES SWINBURNE, Esq., F.R.S., in the Chair.

A paper entitled "The Shannon Scheme and its Economic Consequences" was read by MR. GEORGE FLETCHER, M.A., F.G.S., M.R.I.A., late Member of the Water Power Resources (Ireland) Committee. The paper and discussion will be published in the *Journal* on March 8th.

CANTOR LECTURES.

MONDAY, JANUARY 28th, 1929. DR. R. LESSING, Ph.D., F.C.S., in the Chair. DR. C. H. LANDER, C.B.E., D.Sc., M.Inst.C.E., F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research, delivered the last of his course of three lectures on "The Treatment of Coal." On the motion of COL. THE MASTER OF SEMPILL, a vote of thanks was accorded to Dr. Lander for his interesting and instructive course.

The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

BIOLOGY AND REFRIGERATION.

By Franklin Kidd, M.A., D.Sc.,

Principal Assistant at the Low Temperature Station for Research in Biochemistry and Biophysics. (University of Cambridge and Department of Scientific and Industrial Research).

Lecture III.—Refrigeration and Meat.

With an Introduction on Atmosphere Control in Fruit Storage.

(Delivered November 26th, 1928.)

Retrospect.

In my last lecture we dealt with the apple as a type fruit. We saw how a general scientific study of the properties and behaviour of such a food product leads to a better understanding of the conditions to be observed in its storage and transport in bulk as an article of commerce.

Two features of its behaviour were singled out for special attention :—its behaviour as a respiring and heat producing organism, and the occurrence of a critical stage or climacteric in its life history. At this stage a marked increase in respiratory activity occurs and the maximum development of those volatile substances which contribute to flavour and aroma takes place. Some of these substances are definitely toxic to the fruit, so that, in sufficient concentration, they may end or shorten its life.

We considered, in particular, the relation between storage temperature and length of storage life. The conclusion was reached that there is very generally an optimum storage temperature, above which life is shortened by earlier ripening and consequent fungal rotting, and below which death occurs prematurely from functional disorganisation and breakdown of the still unripe fruit. In this connection we reviewed instances of lack of uniformity of temperature in space and time in large storage chambers, and discussed some of the steps which have been taken to improve these conditions.

The broad general principles which emerged from this rapid review are probably applicable in the case of all fruits, but in many cases the quantitative details have yet to be filled in.

Atmosphere Control in Fruit Storage.

There is undoubtedly a relation between respiratory activity and length of life. The faster the respiration, the shorter the life. Racial and nutritional

factors which are associated with long life are also associated with low respiratory activity. One may quote in this connexion the result of a recent experiment in which 120 apples from ten adjacent trees, 12 from each tree, were stored at a uniform temperature, and the respiratory activity and life duration of each determined.[43] You will see from the accompanying table that length of life is associated with low respiratory activity.

	Life Class.	No. of Apples	Respiratory Activity, CCS. CO_2 per 10 KH at 12° C.
I	75-94 days	11	62
II	95-134 ,,	27	59
III	135-171 ,,	34	56
IV	172-203 ,,	26	54
V	204-317 ,,	17	51

The questions may then be asked: Are there any storage conditions, other than temperature, which can reduce or intensify respiratory activity?—and will such conditions correspondingly retard or accelerate ripening and ageing?

In answer to the first of these queries, we can say at once there are such conditions. One we have already seen, namely, the oxygen concentration in the air of the store. Lowering oxygen concentration to a certain limit decreases respiratory activity. Beyond this limit further lowering sets up a fermentative type of respiration, the products of which may become injurious. Two others may be mentioned, both related to the atmosphere of the store. Carbon dioxide up to a certain concentration retards respiration and such a gas as ethylen in very small traces accelerates respiration.

The answer to the second query is that each of these factors exercises an effect upon rate of ripening corresponding to its effect upon respiratory activity.

The Use of Ethylene Gas to Accelerate Ripening.

The quantitative aspects of atmosphere control have been as yet only very slightly explored, but one or two examples of its practical application may be quoted.

Citrus. Ethylene gas is now used extensively in the citrus packing houses of California to accelerate the ripening of oranges, which are gathered as soon as a statutory content of sugar and acid is attained, though they may still be green. Early fruit of this sort is needed to extend the marketing season and to avoid excess of supply at the peak period of production. It has long been known that the change from green to orange could be hastened by heating the fruit in poorly ventilated rooms. By using smoking oil stoves, damped down so as to yield products of partial combustion, the change can be further accelerated. This primitive method is now being supplanted by electrical heating and the addition of regulated amounts of ethylene gas to the atmosphere.

[43]Kidd, F. and West, C. *Food Investigation Board, Ann. Report*, 1927.

Chace and Denny, dealing with their researches on the use of ethylene in the colouring of citrus fruits, say:—[44]

"With ordinary gas analysis methods it was not possible to detect the combustion product responsible for the coloration of the fruit, but by a series of experiments it was found that the effective constituent was easily adsorbed by bromine and had a specific gravity about equal to that of air. These facts suggested ethylene, and later experiments showed ethylene to be very effective in bringing about the desired change in the colour of citrus fruit. It is not believed that the ethylene enters into any special chemical combination with the green coloring matter of the fruit to form a colorless compound. The experiments indicate that the ethylene stimulates the fruit to renewed activity, and that as a result of these life activities the fruit itself brings about the decoloration of the green pigment.

It is truly surprising what low concentrations of ethylene are able to cause green fruit to turn yellow. One part by volume of ethylene in one million parts of air was found to colour fruit in about the time required by the older kerosene stove method. Even one part in five million produced a satisfactory result, though it required a longer time.

The high temperatures that were formerly thought to be necessary for the colouring process are now known not only to be unnecessary, but positively injurious. Ethylene will colour lemons with sufficient rapidity for commercial purposes when the temperature is 60° F. to 70° F., and will colour oranges at 70° F. to 80° F. It is possible to obtain coloration at lower temperatures if a longer time is allowed."

Tomatoes. The illustration (Figure 1) shows the acceleration of ripening produced by the action of ethylene gas, and of the allied substance propylene, upon tomatoes. "Ethylene gas in concentrations as low or lower than one in

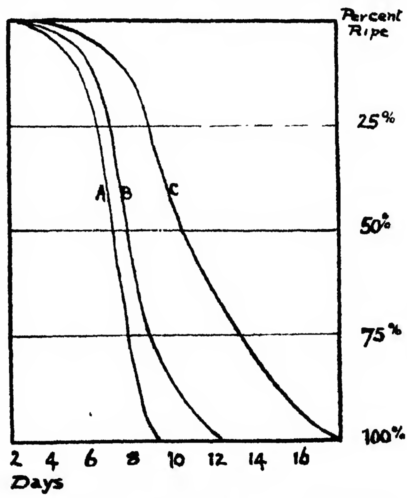

FIG. 1.—The Ripening of Tomatoes Curve A, one part of propylene to 5,000 of air. Curve B, one part of ethylene to 4,300 of air. Curve C, air alone. (After Rosa).

[44]Chace, E. M., and Denny, F. E. *Indust. and Eng. Chem.*, 16, 1924.

4,300, greatly accelerates the development of the red pigment. Other ripening processes, the destruction of starch and of organic acids, and the conversion of insoluble nitrogen to soluble forms are also accentuated." (Rosa).[45]

Bananas. Similar results are produced by ethylene in the ripening of bananas. Its use, however, has not yet been very generally adopted in connexion with this fruit. The banana fruit is shipped and handled in the green state and ripened or conditioned after arrival in warm rooms. It is interesting to note, however, that the use of exposed gas jets has been considered by the trade superior to hot water pipes for the heating of these ripening rooms, and that in the Botanical Laboratories at Cambridge the amazing oligodynamic effects of extremely small traces of ethylene upon the respiration and ripening of fruit was first discovered, owing to an accidental leak of coal gas (which contains ethylene).

The rate of respiration under the influence of ethylene may be doubled or trebled. In the absence of oxygen the accelerating influence upon ripening and ageing is not observed.

Oxygen and Carbon Dioxide Control to Retard Ripening.

Let us now turn to the other side of the picture and consider briefly the practical application of atmosphere control in retarding ripening by reduced oxygen and increased carbon dioxide.

Effects produced by varying the oxygen and carbon dioxide content of the atmosphere have long been known to botanists, particularly in regard to such activities of the plant as growth, germination and carbon assimilation. Recently a thorough investigation had been begun into the effects of oxygen and carbon dioxide upon the rate of respiration and the ripening of stored fruit.[46]

The upshot to date of this experimental enquiry, which has been carried to the commercial scale and in which the apple has been used, is to show that, either by reducing the oxygen content of the storage atmosphere or increasing the

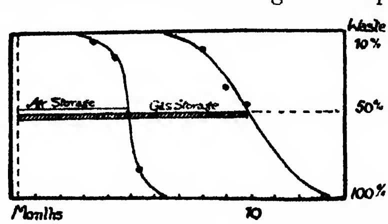

Fig. 2.—Comparative wastage in gas storage and air storage at the same temperature (46.5° F.). Atmosphere in gas storage regulated to contain 9% carbon dioxide and 12% oxygen. (After Kidd, West and Kidd).

[45] Rosa, J. T. *Proc. Am. Soc. Hort. Sci.*, 23, 1926.

[46] Kidd, F., West, C. and Kidd, M. N. *Gas Storage of Fruit, Food Investigation Board, Special Report*, 30, 1927.

carbon dioxide content, the ripening of the fruit is retarded, and that by combining these conditions effects of very considerable magnitude are produced. The results of a typical experiment are shown in Figure 2. In the controlled atmosphere the storage life is twice that in air. If either oxygen reduction or carbon dioxide accumulation are carried too far injurious results follow.

The required conditions of reduced oxygen content and increased carbon dioxide content can be produced simply by restricting and regulating the ventilation of the storage chambers. With such a method, however, the autotoxic effects of the volatile products of the fruits showed themselves, effects which we have already dealt with. Such effects can be avoided in the case of the apple by the use of oiled wrappers.

Co-ordinate Control of Temperature and Atmosphere Composition Necessary.

An important outcome of this enquiry has been to emphasise the interconnexion between temperature and atmosphere composition in relation to the results produced. Temperature and atmosphere composition are not independent variables. The effects produced by any given atmosphere depend upon the temperature.

Reasons for this interdependence of the two variables, atmosphere and temperature, are not far to seek. On the one hand, gases are more soluble at low temperatures, so that for any given amount of a gas in the atmosphere there will be more actually in solution in the tissue at a low temperature than at a higher one.

On the other hand, with temperature change, the rates of the two processes—passage of gases through the skin, and rate of respiration by the living cells within—are unequally affected. In consequence, for any given oxygen and carbon dioxide content in the *external* atmosphere, the composition of the

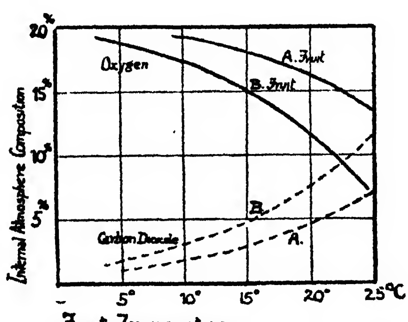

Fig. 3.—Temperature and composition of internal atmosphere of apples. A, fruit is Bramley's seedling from one locality; B, fruit is the same variety from another locality. (After Ekamberam)[46]

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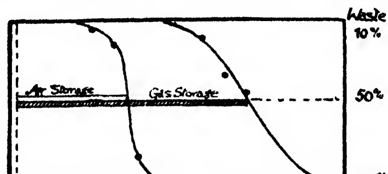

Fig. 2.—Comparative wastage in gas storage and air storage at the same temperature (46.5° F.). Atmosphere in gas storage regulated to contain 9% carbon dioxide and 12% oxygen. (After Kidd, West and Kidd).

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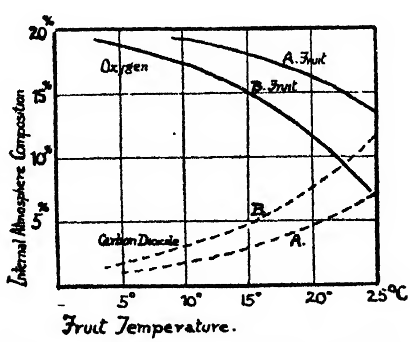


Fig. 3.—Temperature and composition of internal atmosphere of apples. A, fruit is Bramley's seedling from one locality; B, fruit is the same variety from another locality. (After Ekamberam).[46]

internal atmosphere in contact with the living cells within the fruit varies widely according to the temperature of the store. The extent to which this is so will be brought home to you by my next illustration (Figure 3).

At present it appears that optimum results are obtained with regulated oxygen and carbon dioxide atmosphere at temperatures just above the lower limit at which susceptibility to low temperature breakdown commences.

REGULATED VENTILATION OF SHIPS' HOLDS.

On what may be called the negative side, this investigation has important practical bearings. We saw in my late lecture the undesirable effects during overseas transport which follow from the self-heating property of fruit due to its respiratory activity.

Our next illustration (Figure 4) shows the extent to which the composition of the atmosphere of certain types of holds may be modified by the activity of the fruit in consuming oxygen and producing carbon dioxide.[47] In these cases, and until quite recently, no attempt was made to regulate this accumulation of carbon dioxide, which therefore always proceeded until the natural leakage from the hold balanced the production of the gas by the fruit.

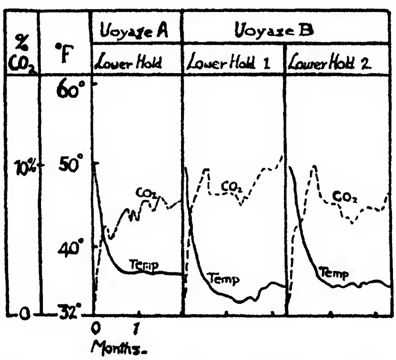


FIG. 4—Temperature and gas records obtained in unventilated refrigerated holds of the grid type carrying apples from Australia. (After Smith).

From this state of affairs, in conjunction with the inequality of temperature through the cargo already discussed, three consequences may follow, two harmful and one beneficial. Thus, provided the accumulation does not go beyond a certain limit, the portion of the cargo above the temperature associated with low temperature breakdown will benefit. The portion of the cargo below this temperature will be harmed. On the other hand, if too great an accumulation of carbon dioxide occurs the whole cargo will be damaged.

ATMOSPHERE CONTROL EXPERIMENT STATION.

In concluding this section dealing with atmosphere control, as an auxiliary to temperature control, in the storage of fresh fruit and vegetables, a word

[47] *Food Investigation Board, Special Report* 21, 1925.

of warning may be uttered. We are on new ground and must beware of pitfalls. Temperature variation is a normal factor of environment. We are all traditionally familiar with its broad effects. In controlling atmosphere composition we introduce conditions with which we are not familiar. We shall have to create all our experience artificially and by experiment. For this reason it has been thought desirable to establish an experimental station especially equipped for simultaneous control of temperature and atmosphere composition, and such a station is now in course of erection at East Malling, in Kent.

There is no time here to enlarge further upon this topic, but I think that the broad statements I have been able to make are sufficient to indicate that in atmosphere control we can see the elements of a new and powerful auxiliary means of controlling the forward march of the life processes in the storage of fruits and fresh vegetables.

REFRIGERATION AND MEAT.

We have now to consider animal flesh as a food product, and to discuss some of the principal problems associated with its preservation during the periods of storage and transport which the industrial era have rendered an essential feature in world economy.

Meat in its properties and behaviour differs from fruit and vegetables in many ways. In the first place, it is in a post-mortem state. Though it still possesses a complex organic structure, this structure is in course of irreversible disintegration. Our questions must be, therefore, how does this disintegration proceed, and how may it be regulated either in speed or character by control of temperature or other storage conditions, or by adjustment of the ante-mortem variables of race, age and nutrition or physiological state.

I may perhaps remind you here that some progress in disintegration is generally believed to be desirable for the product to attain its highest quality. The practical problem is, therefore, to handle meat and fish in such a way from the producing centre to the consumer that it may be in its best stage for immediate consumption.

AUTOLYSIS.

Biologists are naturally more interested in the mechanism of the living state than in the sequences of post-mortem decay, but this position is reversed when we begin to study the behaviour and properties of meat in storage. One general feature of post-mortem change can at once be stated. The initial changes that proceed are those activated by the enzyme (or ferment) systems of life, which are disorganised, but not put out of operation by the death of the tissue. Such changes are the hydrolysis (or splitting) of proteins into their simpler components, the soluble amiño-acids: the hydrolysis of fats and the splitting of the muscle sugars to lactic acid. These changes are similar to those which occur in digestion, and this type of post-mortem disintegration is known as the autolysis or self-digestion of the tissue.

In the study of the natural course of disintegration of animal flesh there are, of course, the different main types of tissues to be considered—muscle tissue, connective tissue, fat tissue, and gland tissue, so that we again meet (as in the case of plants) the complications introduced by heterogeneity. We often find, for instance, in the storage of meat, that the disintegration of fats giving rise to rancidity may render the product uneatable, while the muscle tissue is still in good condition.

The principles then governing the behaviour of animal tissues and their constituent materials during their post-mortem disintegration form a whole chapter of biochemistry, which is of fundamental importance in relation to the preservation of foodstuffs, but which we have, as yet, hardly begun to explore.

Bacterial and Mould Decay.

With the breakdown of the living state and the onset of post-mortem disintegration, animal flesh becomes at once a rich medium for the growth of bacteria or moulds. The progressive development of these organisms is a secondary complication, and constitutes a field of investigation in itself. The identity of the organisms has to be determined, how they multiply, and the effects they have on the product under various conditions of storage. The interactions between a food product and populations of saprophytic micro-organisms, and the effects of temperature on the same, are of particular interest in connection with the ripening and storage of cheese.

A feature in which such products as meat and fish differ from fruits and vegetables lies in the absence of an intercellular network of air channels. In the living state the essential oxygen is distributed throughout the tissues by the blood stream. After death there is little access of free oxygen to the deeper tissues. This fact has an influence upon bacterial and mould development. Moulds and certain bacteria require oxygen, and are therefore limited to the surface. Other bacteria are able to flourish in the absence of oxygen, and these find their way into the deeper parts of the flesh.

The Freezing and Chilling of Meats.

With this slight introduction let us proceed at once to consider the effect of temperature. It was early discovered without the assistance of science that some forms of flesh, notably mutton, could be frozen hard ; handled and stored in the solid condition ; and subsequently thawed out, retailed and cooked, without any very marked depreciation in quality. It was also found that other forms, notably beef, were much injured by freezing, juice flowing from the product when it was thawed and its quality after cooking rendered tasteless and dry.

This form of deterioration is so serious that frozen beef has come to be regarded as a low grade article of commerce. For transport and storage of good-quality beef the trade therefore relies on retarding post-mortem disin-

tegration by "chilling," that is, by lowering the temperature without freezing. The storage life in the chilled state is, however, strictly limited, so that chilled beef is a highly perishable article of commerce. Perfected and smooth running organisation is essential for success. Frozen meat, on the other hand, is practically a non-perishable article, and disturbances, such as strikes, wars, or delays in transit, need not necessarily dislocate supplies. The following figures show the relative extent of the trade with the U.K. in chilled and frozen beef:

Country of Origin.	*Quantities.*	
A. FROZEN. (Including Offal).		
U.S.A.	84,569	cwts.
Uruguay	263,455	,,
Argentina	1,447,898	,,
Australia	1,148,978	,,
New Zealand	540,828	,,
Other Countries	100,970	,,
	3,586,698	,,
B. CHILLED.		
Uruguay	700,874	,,
Argentina	8,956,806	,,
Other Countries	20,663	,,
	9,678,343	,,

ICE FORMATION IN THE TISSUES AND ITS EFFECTS.

The injurious effects of ice formation, which are especially noticeable in the case of beef, thus constitute one of the main problems connected with the cold storage of meats. At the outset it may be recalled that we have already assembled certain generalisations with regard to the nature of the injurious effects produced by ice formation in plants, using as our criterion of injury the death of the organism. We found race, nutrition, and age had a marked influence on the degree of injury caused by ice formation.

We also found that physiological states could be induced by artificial treatment which rendered the organism resistant to freezing injury. And in analysing the cause of injury we isolated a number of factors:—the effects of concentrated salt solutions, such as result when pure water is withdrawn from the system, upon the colloidal organisation of the protoplasm; the protective action of such substances as sugars; the water holding capacity of the colloids against the forces of ice formation; and slow changes occurring in the desiccated system after the separation out of water as ice.

The Manner and Position of Ice Formation in Beef Muscle.

Let us to-night first enquire where and how the ice is formed in the freezing of beef muscle tissue.

The unit in muscle tissue is the muscle fibre surrounded by a limiting membrane, the sarcolemma. These fibres are associated in bundles surrounded by elastic sheaths of connective tissue similar to that which encases the whole muscle. Within the muscle is a network of blood vessels and nerves. From the finest blood vessels a fluid filters out and each fibre is bathed in this. Chemically, muscle consists of 75%-80% of water, 1% of salts, mainly potassium and sodium phosphates and chlorides, 15-20% of proteins. Among other constituents are sugars and nitrogenous bases.

In the living state it is now thought that the fibres contain protoplasm in a liquid or semi-liquid state dispersed through a delicate solid frame work. On death, and during *rigor mortis,* this liquid changes to a gelly with evolution of heat, which is in the order of 1 B.T.U. per lb.[48] Under commercial conditions *rigor mortis* is established before freezing commences.

Ice may be formed both within the fibres or between them. The extent to which this is so, one way or the other, appears in the main to be a function of the rate of cooling. When cooling is rapid the centres of ice formation are extremely numerous and originate within and without the fibres. When it is slow they are few and originate almost exclusively outside, between the fibres, either in the lymph or in the connective tissues.

During freezing the curve of temperature plotted against time flattens out when a temperature of about 1.5°C. has been reached. At this temperature a very considerable portion of the water content of the meat solidifies, and during the process the temperature of the meat does not alter. From 1.5°C. the curve falls slowly to about - 3°C., after which the fall becomes more rapid. The flattened part of the curve corresponding to the period in which the bulk of the ice is formed is spoken of as the *thermal arrest*, and its duration is used as a standard by which to compare rates of freezing.

The following Figures—5, 5*a*, and 6—illustrate the way in which ice is formed in beef muscle which has been frozen at various rates. The first of these illustrations shows thin slices of beef as they appear under the microscope at low temperatures, with the ice in them. The second and third show slices cut from pieces of meat in the frozen state and "fixed" before thawing by dropping them into 10% formalin and salt below freezing point. They are thinner sections and show the muscle fibres distinctly, and the degree to which they have been distorted by ice formation. From these illustrations it is clear that, with progressive increase in the rapidity of cooling, we range from a condition in which water and tissue elements become widely separated in space in the frozen state of the tissue to one in which they remain intimately associated. A feature which is well illustrated in one of the microphotos

[48]Smith, E. C. *Food Investigation Board, Ann. Report,* 1927.

in Figure 6 is the fracture of the gelly substance of the individual fibres by the ice crystals. This is a characteristic of fairly rapid freezing.

The details of the experiments of which the results are illustrated in Figures 5 and 5*a* were :—[49]

Figure 5.

I	Freezing medium	Liquid air (-193°C.)	Thermal arrest,	0 minutes.
II	,, ,,	Brine :	,, ,,	24 ,,
III	,, ,,	Brine :	,, ,,	30 ,,
IV	,, ,,	Brine :	,, ,,	60 ,,
V	,, ,,	Brine :	,, ,,	120 ,,
VI	,, ,,	Air :	,, ,,	1200 ,,

Figure 5*a*.

I Same as II above.

II Same as III above.

III Freezing medium, Air : Thermal arrest, 600 minutes.

RATE OF COOLING AND THE "GRAIN" OF ICE FORMATION.

In considering what happens in the formation of ice, we conceive that some degree of super-cooling precedes the formation of ice at each centre of crystallisation. As soon as crystallisation sets in the temperature at that centre and in its immediate neighbourhood rises to the true freezing point, owing to the heat liberated in ice formation.

We may picture, then, that in any system there exist a large number of potential centres of crystallisation which are brought into action by various degrees of super cooling. They vary– that is to say, in regard to what may be called their initial potency. When cooling is slow the few most potent centres get a sufficient start to prevent the other centres becoming operative. The heat release at these few centres balances the slow removal of heat and so prevents further super-cooling anywhere else in the mass. Ice formation is then coarse "grained." When, on the other hand, cooling is rapid, super-cooling may go beyond the point at which the first few centres become operative and so bring other centres into action. This will proceed till again the heat liberated in the more rapid ice formation balances the heat removed in the more rapid cooling. The faster the cooling, the greater the number of centres of crystallisation and the finer the "grain."

Flesh, as we have seen, is a highly heterogeneous system, and it would appear that the interfaces between fibres, or between fibres and interstitial connective tissue, are locations of pre-potency in the initiation of crystallisation.

RATE OF COOLING AND ICE FORMATION IN GELATINE GELLIES.

My colleague, Dr. Moran, has recently made a thorough study of the phenomena of ice formation in gelatine gellies, which constitute a system analo-

[49]Cook, G. A., Love, E. F. J., Vickery, J. R., and Young, W. J. *Australian Journ. Exper. Biology and Med.*, III, 1926.

gous to, though simpler than, muscle tissue.[50] Microscopical examinations showed that the number of centres of crystallisation increased as the rate of cooling was increased.

With very rapid cooling, *e.g.*, in liquid air at −193°C., the ice formed appears as a fine regular grain of minute spheres about 0.003 millimeters in diameter. The masses of desiccated gelatine between the ice are of about the same dimensions as the ice grains.

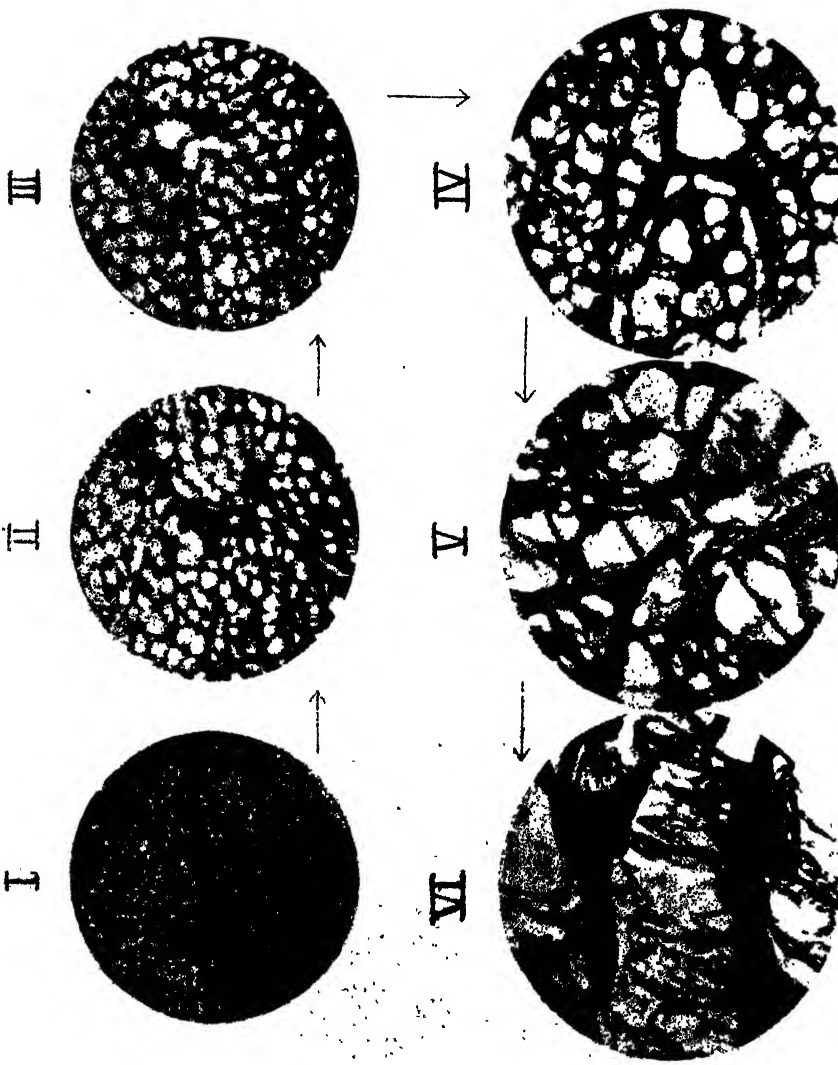


FIG. 5.—Thin slices of frozen beef as seen under the microscope in the frozen state Ice white, tissue elements dark. Note effect of rate of cooling on degree of spatial separation of ice and tissue elements The most rapidly cooled is No. 1, the most slowly is No VI (After Cook, Love, Vickery and Young).

[50]Moran, T. *Proc. Roy. Soc.*, 1926 (A) 112, and *Food Investigation Board, Ann. Report*, 1924.

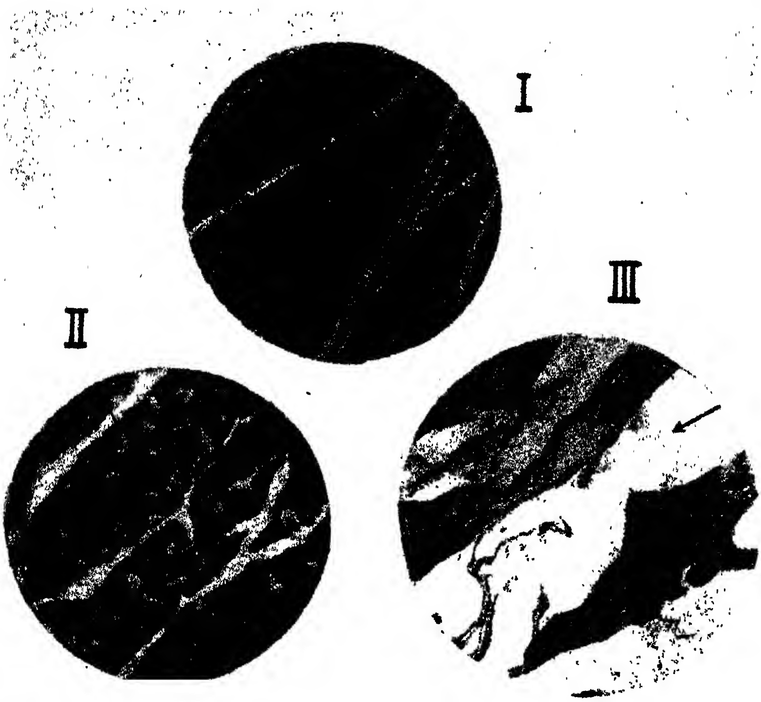
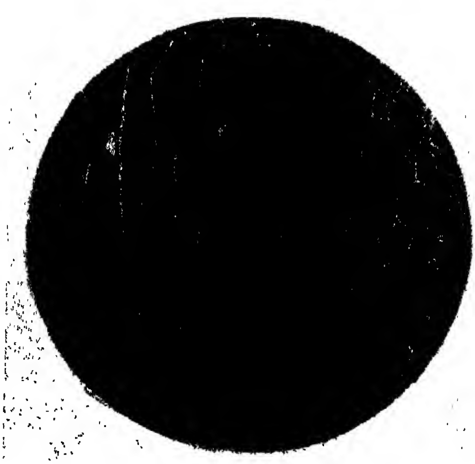
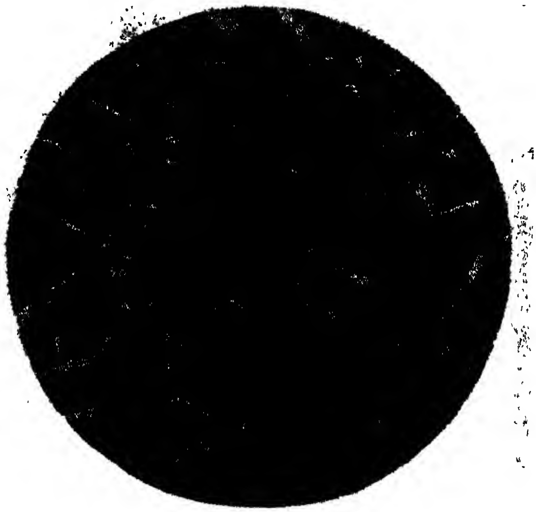


FIG. 5 (a).—Thin slices of beef, which has been "fixed" in the frozen condition, as seen under the microscope after subsequent treatment so as to bring out more clearly the tissue elements. The most rapidly frozen is No. I, the most slowly is No. III. The muscle fibres (dark) have been cut across transversely. Note varying degrees of tissue distortion. The white areas are spaces once occupied by ice (After Cook, Love, Vickery and Young)



Fresh Beef. x(160).



Brine Frozen Beef. x(100)

Liquid Air (−190° C.). Frozen Beef x(100).
FIG. 6.—(Moran and Hale, unpublished work).

With very slow cooling of small pieces (discs 1.5 cm. x 0 3 cm.) the surface was prepotent as a centre of crystallisation, and the ice formed solely as shell or crust enclosing a core of desiccated gelly.

At intermediate rates of cooling, in addition to surface ice, internal ice is formed, but the centres are relatively few, resulting in irregular masses of

mixed ice and gelly. The ice masses are, as it were, honeycombed by the desiccated gelly strands.

If the gelly frozen is a concentrated one, the irregular honeycombed internal ice masses are replaced by a regular disposition of shells of alternate ice and desiccated gelly disposed concentrically about the original centres of crystallisation. These form very pretty structures. The appearance of one in section, much enlarged under the microscope, is shown in Figure 7. In the same figure is shown a piece of gelatine only very slightly enlarged with these circular ice masses scattered through it.

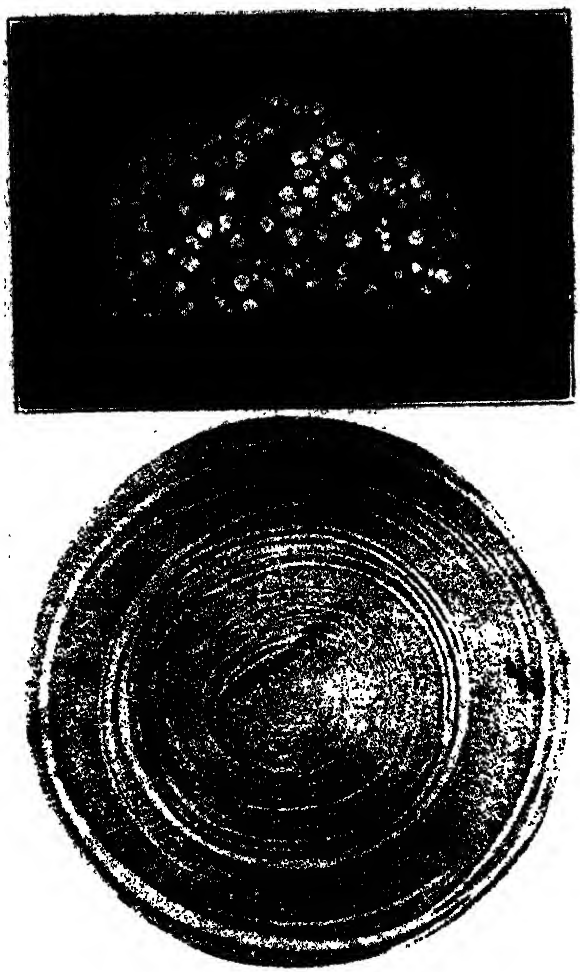


Fig. 7.—Type of ice formation in concentrated gelatine gelly. (After Moran).

FACTORS DETERMINING RATE OF COOLING.

The factors which determine rate of heat transference in cooling are numerous. They are the thermal conductivity, specific heat, density, latent heat, specific surface and nature of surface of the cooled body; and, secondly, the temperature, conductivity, specific heat, density and degree of agitation of the external medium.

A review of the influence of these factors treated on a quantitative basis has been set out by Stiles in one of the special reports (No. 7) of the Food Investigation Board. The most important of them from the practical point of view are the nature of the medium surrounding the body to be cooled, its degree of agitation and the size of the cooling object. I have chosen a few illustrations to remind us of the relative degree of the influence of these factors in particular. (Figures 8, 9, 10).

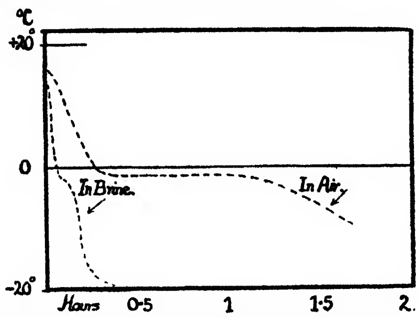


FIG. 8.—Rate of freezing and nature of cooling medium. Curves are temperature records taken at centres of two 15 gram pieces of beef cooled, one in air at —20° C., and the other in brine at —20° C. Thermal conductivity (calories per c m. per degree per sec.) of brine about 0.001, of air about 0 00005. (After Stiles).

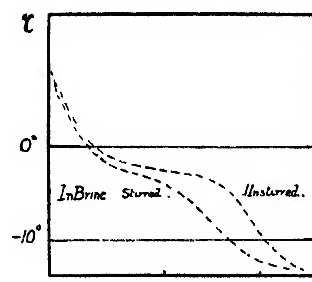


FIG. 9.—Rate of freezing and agitation of cooling medium. Curves are temperature records at centres of two 15 gram pieces of beef, one frozen in brine kept artificially stirred, the other in still brine. (After Stiles).

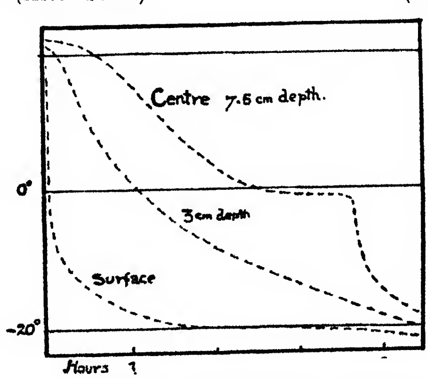


FIG. 10.—Rate of freezing and size. Curves are temperature records taken at different depths in a 15 c.m. cylinder of 5% gelatine. (Adapted from Stiles).

Subsequent Effects of Different Rates of Freezing.

To proceed, let us next enquire how these gradations in the manner of ice formation, which depend on the rate of cooling, influence the subsequent properties of the tissue after thawing. Taking first the quantity of drip, we find that this is progressively greater the slower the freezing and the greater the consequent spatial separation of ice and tissue elements. But we find also that there is much less drip if the thawing is conducted slowly than if it proceeds rapidly. This is what might be expected. Interest attaches rather to the quantitative aspect of the results.

In the first place, then, drip was not entirely eliminated in the experiments which we have been considering and of which you have seen some of the results illustrated (Figures 5 and 5*a*), except in the case in which the tissue was frozen in liquid air. In this case thermal arrest was practically eliminated. One can, however, regard the drip as negligible in these cases in which the thermal arrest was not of more than 0.5 hours duration. If we are to achieve this critical rate in the centres of the freezing masses, the laws of heat flow necessitate that the pieces employed be of the size of small joints rather than of whole sides, and also that freezing be conducted by immersion in an agitated liquid rather than in air.

It has been found, also, that the course and extent of the autolysis of the meat after thawing is greatly modified according to the rate of freezing. We can measure the course of autolysis by estimating the increase with time of the nitrogenous substances in the meat which are non-coagulable by heat, these substances being derived by hydrolytic degradation from proteins. Slow freezing results in a greater and more rapid degradation of the proteins of the meat as compared with that occurring in unfrozen meat. In the case of meat which has been frozen rapidly the course of autolysis after thawing

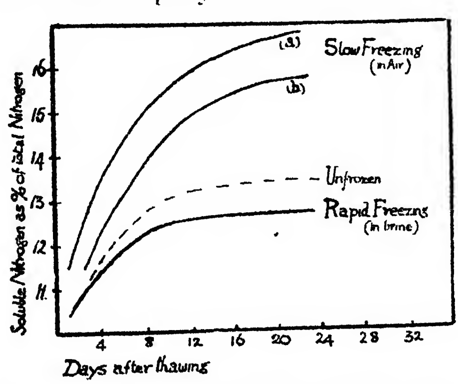


Fig. 11.—Effect of slow (air) freezing and rapid (brine) freezing on autolysis of beef muscle after thawing. (*a*) was frozen directly after killing; (*b*) was exposed for a day at 0° C. before freezing. (After Fearon and Foster).

is not far different from that of fresh unfrozen meat. The illustration (Figure 11) shows the course of autolysis in unfrozen shin beef muscle as compared with that in similar muscle after 24 hours' immersion in brine at −18° C.[51]

RATES OF THAWING AND THEIR EFFECTS.

So much for the effects which have their origin in the rate of freezing and manner of ice formation. Let us next consider, again as far as possible on a quantitative basis, how these effects may be modified by varying rates of thawing. It has been claimed that if the rate of thawing be very slow, drip is eliminated owing to complete reabsorbtion by the tissue of the water and solutes separated out in freezing. This is probably not true. But it is true that reabsorption takes place to a considerable extent and that slow thawing, which prevents the draining away of the thaw liquid by supplying it not faster than it can be reabsorbed, greatly diminishes drip. For example, the following estimations made on small pieces of beef are reported by Cook, Love, Vickery and Young :—

Comparable pairs (a and b), identically frozen.	*Thermal arrest in thawing.*	*Net Drip. Per cent. of fresh Weight.*
a slowly thawed	18 hours	0.7%
b rapidly thawed	2.2 ,,	3.7%
a slowly thawed	90 ,,	0.8%
b rapidly thawed	4 ,,	1.6%
a slowly thawed	54 ,,	1.7%
b rapidly thawed	14 ,,	3.4%

Microscopical examinations also show clearly that the muscle fibres reabsorb much of the liquid frozen out of them if thawing is slow.

INFLUENCE OF RACIAL AND AGE FACTORS ON FREEZING EFFECTS.

Let us next consider very briefly examples of the influence of race and of age upon the magnitude of these phenomena of tissue distortion by ice formation and of drip on thawing. Generally speaking, with regard to the age of the tissue, it may be said that there is much less drip in the case of the tissue of younger animals. Microscopical examination also reveals the fact that less ice is formed between the fibres.

The same characteristics differentiate mutton and beef. There is less drip from mutton, and also less spatial separation between the tissue elements and the ice formed. For instance, the appearance under the microscope of mutton slowly frozen in air with a thermal arrest of 10 hours (Figure 12) is equivalent to that of beef frozen so rapidly as to show a thermal arrest of only 0.75 hours (Fig. 5, iv).[52]

[51]Fearon, W. R. and Foster, D. L. *Biochem. Journ.*, 16, 1922.
[52]Cook, Love, Vickery and Young. *Loc. Cit.*

FIG. 12.—Thin slice of slowly frozen mutton (frozen in air at —14° C.) as seen under microscope in frozen state. Thermal arrest 600 minutes. Compare beef similarly frozen (Figure 5, VI, and figure 5 (a), III). (After Cook, Love, Vickery and Young)

THE FREEZING OF FISH.

The practical application of the facts we have so far discussed with regard to rapid freezing appears at present to be rather to the handling and storage of fish than to meat. Slow freezing is followed by the same type of undesirable effects in fish as in the case of beef. The majority of fish are units small enough to permit their freezing rapidly enough in agitated brine (NaCl) to avoid these effects.

Experiments have shown that to freeze a fish four inches thick to -7°C. at the backbone takes $37\frac{1}{2}$ hours in air at -7°C., 11 hours in air at -20°C, and only $1\frac{1}{4}$ hours in brine at -20°C; or to freeze to -20°C at the backbone 15 hours in air as against $1\frac{3}{4}$ hours in brine at -20°C. The freezing is, therefore, 8 to 10 times as fast in brine as in air.

Incidental difficulties are encountered in freezing fish by this method, one of which is that they may easily freeze together into masses. There is an ingenious device (Figure 13) contrived by my colleague Mr. Piqué for preventing this. The principle of this device is that the fish is frozen in a revolving perforated cylinder immersed in the brine. Inside the cylinder are fitted baffle plates which keep the freezing fish in constant motion as the cylinder revolves, so that they freeze as separate units. The device is suitable for large scale operation on sea or land.[53]

Incidental to freezing by immersion in brine, the surface appearance of meat may be affected. A superficial browning results due to an irreversible

[53] Piqué, J. *Proc. IV Internal Cong Refrig, I*, 1924.

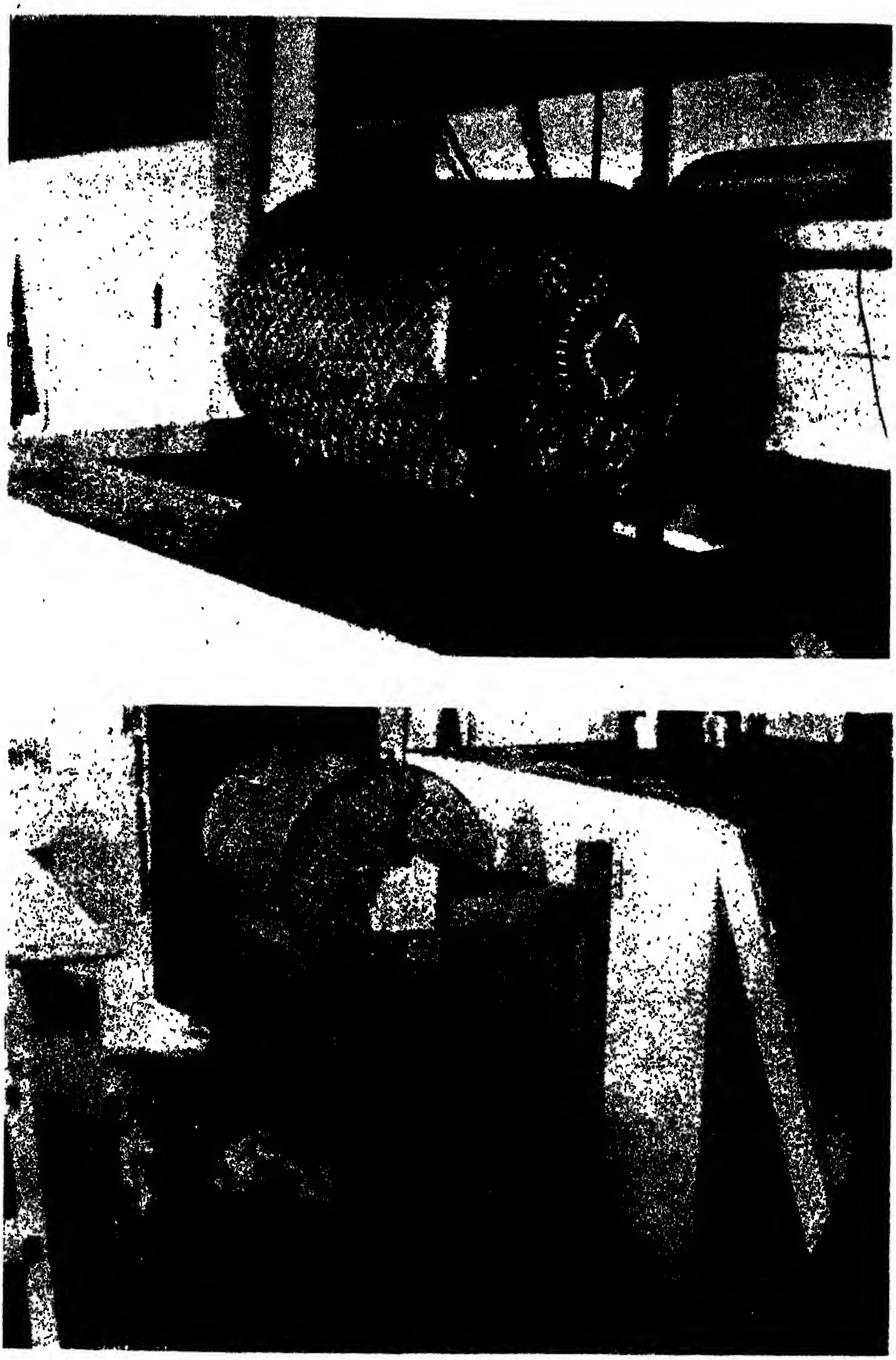


FIG. 13.—(After Piqué).

change in the red colouring substance, hæmoglobin to methhæmoglobin. This difficulty can, however, be met by adding a certain percentage of free ammonia to the brine, or by excluding oxygen from the flesh for sometime prior to freezing.

DEPTHS OF FREEZING AND ITS EFFECTS.

We have so far been examining ice formation solely from the point of view of the effect of the *rate of freezing upon the disposition of the ice formed.* Let us shift our point of view and consider *the amount of ice formed at different depths of freezing* and the effect of various factors upon this.

In a simple colloid gelly such as gelatine the amount of water that separates as ice depends upon how low the temperature is. We can speak of freezing to equilibrium at any given temperature—by which we mean that if the gelly is placed at –7°C., for example, a definite quantity of its contained water will freeze and no more. And further, if subsequently the frozen gelly is transferred to a lower temperature, 15°C., for example, a certain further definite quantity of water will freeze ; or, reversely, if it is subsequently transferred to a higher temperature, say –5°, a certain definite quantity will thaw and no more, and be reabsorbed by the gelly. The next two illustrations show you how long it takes to reach this equilibrium (Figure 14) and also the amounts of water which are indefinitely retained by the gelly against the force of ice formation at different depths of freezing (Figure 15). It may be noted that beyond a certain point no more water freezes, however low the temperature is taken (within the limits of the experiments), in spite of the fact that there is still much water in the colloid, about 35% in fact.[54]

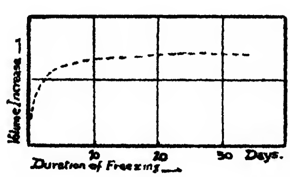


FIG. 14.—Showing time taken to reach equilibrium in freezing at a constant temperature, as indicated by measurement of increase in volume. In the above case of 6.56 grams of a 43.7% gelatine gelly at –11° C., it was 26 days.

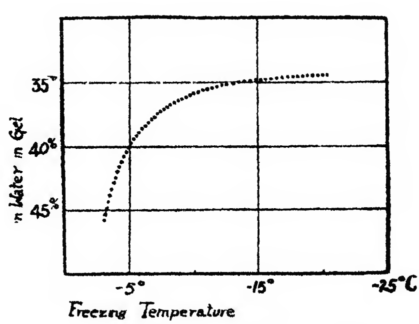


FIG. 15.—Relation between depth of freezing and amount of ice formed at equilibrium in a gelatine gelly. Unfrozen water as % in gelly at equilibrium. (After Moran).

When we turn from gelatine to meat the same phenomenon is encountered, as is illustrated by the following figures (after Plank).[55]

[54]Moran, T. *Loc. Cit.*

[55]Plank, R. *Z. ges. Kalte-Ind.*, 32, 1925.

Temperature.	*Percentage of water present which freezes.*
-1.5°C	42.1%
-2.0	49.7
-3.0	58.3
-5.0	68.0
-10.0	80.2
-15.0	86.7
-20.0	91.0
-30.0	96.2
-45.0	99.5
-55.0	100.0

EFFECT OF ACIDITY ON AMOUNT OF ICE FORMED.

We may notice next that acidity (conc. of H ion) of the gelly considerably affects its water holding power against the force of ice formation. The next illustration (Figure 16) shows how the amount of unfrozen water at equilibrium increases with increased acidity of the gelly.

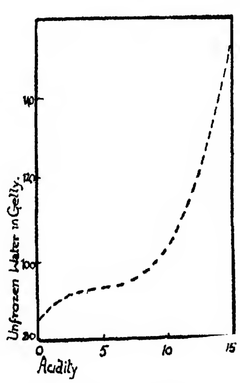


FIG. 16.—The gelatine ice equilibrium curve at —3° C. The acidity units are c cs. of N/HCl. per 10 grams of dry gelatine. The water unavailable for freezing is expressed as grams per 100 grams of gelatine. (After Moran).

This is of particular interest as we know that lactic acid increases in the muscle after death. We may recall that a period in chill before freezing has been found to diminish the drip from beef after thawing. The following figures from experiments by Cook, Love, Vickery and Young may be quoted :—

Length of time at 1°C. between chilling and freezing.	*Thermal arrest. Freezing.*	*Thawing.*	*Net Drip. Per Cent. of fresh Weight.*
2 hours	1 hour	1 hour	5·5
5 days	1 ,,	1 ,,	4·7
10 days	1 ,,	1 ,,	2.8
15 days	1 ,,	1 ,,	4·9
20 days	1 ,,	1 ,,	2.2

"Up to the end of ten or eleven days' storage at a temperature of 1°C. before freezing there is a definite decrease in the drip from beef after freezing and thawing. When stored for a longer period a slight increase is observed."

EFFECTS OF DESSICATION, COMPRESSION AND FRACTURE PRODUCED BY ICE FORMATION.

We may proceed now to enquire what effects the drying and compression of gellies, depending on the depth of freezing, may have. That changes do occur in the desiccated gellies when water is forced out of them by freezing we know. The water absorbative power of some gellies is completely destroyed by freezing, so that after thawing their desiccated flakes remain permanently as such. Broadly, the extent to which this happens appears to be a matter of degree as between different substances in the gelly state.

It is unfortunate that we know as yet so much less about the structure of gellies in terms of their molecular organisation than we do about crystals. To illustrate to you the sort of thing that may happen, however, let us consider what happens to gellies in solution when they are frozen. The minute unit-particles of the gelly which are floating freely dispersed, for example, in fresh meat juices or milk, apparently unite into larger aggregates when frozen out by slow ice formation. On thawing, these larger particles persist as such and the quality of the milk or meat juice has been altered.

Vickery has carried out experiments in which he took the press juice from fresh beef muscle and, after freeing it from all particles of gelly big enough to be thrown down by centrifuging, froze the juice at various rates. After thawing, extensive brownish coloured precipitates of a protein appeared, and the thawed juice was full of particles big enough to be thrown down by the centrifuge.[56]

The drying and compression of the gelly following freezing may therefore result in the linking up of smaller aggregate units into larger ones. The concentration effected may also accelerate chemical changes.

Corresponding with varying coarseness in the grain of ice separation must go a varying texture of fracture in the original uniformly coherent gelly. That the separation of ice ruptures a gelly structure irreversibly is shown by an

[56]Vickery, J. R. *Australian Journal Expet. Biol. and Med.*, III, 1926.

interesting experiment carried out by my colleague, Mr. Callow.[57] A supercooled gelatine gelly in a test tube was " seeded " with a crystal of ice at the top and the rate of the downward speed of ice formation noted. This varies with the acidity and concentration of the gelly, etc.

In the present case it was slow—3 centimetres an hour. After freezing was complete the gelly was thawed, then again supercooled, and the experiment repeated. The result was startling. On seeding a second time ice formation *immediately* spread to the bottom of the test tube, following the paths of rupture formed by the original crystallisation. This indicates that, though reabsorption may take place, ruptures in the gelly structure are more permanent.

Depths of Freezing and Effects of Salt Concentration.

So much, then, for irreversible effects produced in pure gellies under the concentrating and compressing effect of ice formation. When we turn to the complexity of tissue, the first major complication that we meet is the presence of salts.

We saw in my first lecture that there was a definite critical depth of freezing in the case of the yolk of eggs. Yolks can be frozen and thawed down to -6°C. without change. If they are frozen below this the yolk changes to the condition found in a soft boiled egg. It is stiff and pasty. This was traced to the action of the salts concentrated in the yolk during ice separation. It may be remarked that this action takes an appreciable time, so that if (and only if) the yolk is frozen extremely rapidly in liquid air at -190°C., and thawed equally rapidly in warm mercury the irreversible effect is avoided.

Freezing and Recovery of Living Muscle.

A most interesting recent discovery in this connection has been made with regard to living muscle—muscle, that is to say, which, though excised from the body, will still contract or twitch in a normal way if stimulated. Such a muscle can be frozen and recover. But there is a critical limit of temperature, corresponding to a critical limit of desiccation, as tested independently without freezing, beyond which death ensues.

The behaviour of living muscle (frog's sartorius) frozen to equilibrium at different temperatures and then placed in water is depicted in the next illustration (Figure 17). The failure to take up water is taken in this case as a criterion of the irreversible death change. This change occurs on the removal of approximately 78% of the water present, either by direct drying, or by freezing to equilibrium at approximately -2°C.

" Chilled " Beef Transport.

At this point interest shifts to the other method of preserving beef during transport and storage; the method known as " chilling," as opposed to

[57]Callow, E. H. *Food Investigation Board, Ann. Report*, 1924.

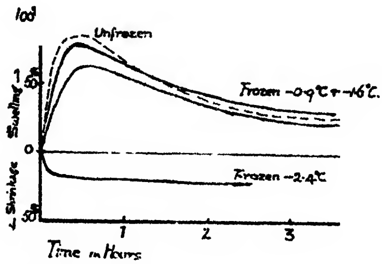


FIG. 17.—The uptake of water by Frog's sartorius muscle. Note marked difference in state of muscle after freezing to – 2.4° C., as compared with unfrozen muscle and muscle frozen only to – 1.6° C.

freezing. This distinction, in so far as it implies that chilled beef has never contained ice, is a misleading one.

Let me explain. The conditions in the refrigerated holds carrying beef from the Argentine are of great importance and interest. The chambers are cooled by brine circulating in grids on the walls and roofs and there is generally no artificial air circulation.

Temperature distribution surveys, such as I described to you in my last lecture in connection with fruit transport, have not yet been carried out. But the striking fact is that the average temperature maintained, as shown by the ship's thermometers, is about - 2°C. This temperature is below the freezing point of beef (*i.e.*, -1°C. av.), and, in fact, much of the chilled meat in the markets contains an appreciable amount of ice.

DIGRESSION CONCERNING ATMOSPHERIC HUMIDITY AND ITS EFFECTS.

Now there is a reason given for this state of affairs which is of some interest. But in the first place a digression will be necessary, in order for us to understand something of another phase of this subject of food preservation, namely, the question of the humidity of the atmosphere and its effects.

In the bulk storage of water-evaporating biological material, the equitable control of humidity throughout the mass presents an even more difficult problem than that due to the heat and gas producing properties of such material. Humidity surveys in commercial stores parallelling the temperature surveys above mentioned, have been begun by my colleague Dr. A. J. M. Smith, and also quantitative work upon evaporation of water from biological surfaces.[58]

As to the effects traceable to the degree of humidity of the storage air, these are two-fold. First the effect upon loss of water and hence of valuable weight; secondly, the effect upon mould growth.[59] In the case of chilled meat the growth or otherwise of moulds on the surface may be said to be largely determined by whether a definite rate of drying of the surface proceeds or not. And in this humidity plays a deciding part.

[58]Smith, A. J. *Food Investigation Board, Ann. Report*, 1927.
[59]Tomkins, R. G. *Food Investigation Board, Ann. Report*, 1927.

Humidity and Temperature in "Chilled" Beef Carriage.

To return, then, to the carriage of Argentine beef. In the closed holds filled with hanging carcasses the humidity is naturally very high. It is reduced by the deposition of snow on the brine pipes. Nevertheless, it is found that the cooling necessary to maintain simple chilling without ice formation is not enough to adequately reduce the humidity of the hold atmosphere. In the formation of ice, heat is liberated, and for the formation of relatively little ice in the meat, the temperature of the pipes can be carried much lower and hence a lower humidity obtained.

If the facts are as stated here, clearly there is much likelihood that portions of the cargo fall to temperatures below the average figure given above, *i.e.*, -2°C., while other portions may be above this temperature. We are led at once to enquire, especially from what we have just seen as to the existence of a critical temperature of –2°C for the living muscle, whether or not any such critical temperature exists for beef.

A Critical Depth of Freezing for Beef.

A recent series of experiments conducted by Dr. Moran at the Low Temperature Research Station at Cambridge, indicate that this is so. Sides of beef were frozen to equilibrium at steady temperatures of –1.5°C, –1.8°C., –2.5°C. After prolonged storage period at these temperatures the meat from –1.5°C. and –1.8°C. showed little or no drip, as compared with that from –2 5°C. Perfect preservation for 60 to 70 days, except for traces of rancidity in the fat, was achieved.[60]

The Transport of "Chilled" Beef from Australia.

During the past three years four experimental shipments of Australian "chilled" beef have arrived in this country. Observations by the staff of the Low Temperature Research Station have been made on the last three of these, after discharge from the ship. The following table (Moran & Vickery)[61]

Shipment	Quantity of Meat.	Length of Journey.	Av. temp. of Chamber as given in ship's log. °F.	Mean loss of Weight Per cent.	Space Occupied per ton of meat. Cub. ft.	Remarks.
1	(*a*) 758 hinds. (*b*) 41 hinds.	55 days 41 days	29–30 29–30	(*a*) 0.88 (*b*) —	108 —	(*a*) Serious mould growth. (*b*) Slight mould growth.
2	298 hinds.	65 days	27	3.2	133	Slight mould growth: meat rather hard owing to ice formation.
3	100 hinds. 60 crops.	48 days 48 days	28.5 28.5	3.35 4.71	144 144	Slight mould growth: Bacterial infection on crops.

[60] *Food Investigation Board, Ann. Report*, 1927.
[61] *Food Investigation Board, Ann. Report*, 1927.

based on these observations and on information supplied by the ship's engineers and the promoters of the shipments summarises the results. Moran and Vickery conclude that "the experiments leave little doubt that *slightly frozen* beef from Australia can be landed in Great Britain in good condition."

From the practical point of view it appears, therefore, that both "chilling" and freezing are feasible as methods of preservation during the transport of beef from the Antipodes. Both have their difficulties and disadvantages, and neither yields, as yet, a first-class product.

If we adopt the freezing alternative, improvement is to be sought by concentrating attention upon pre-storage factors of age, breed, race and nutrition; upon rate and depth of freezing; and upon rate of thawing. Quantitative experiments on a semi-commercial scale are needed for the continuous study of the effect of these variables upon quality and drip and in order to put the matter on an *ad hoc* basis of fact. The introduction of new trade methods for the handling of smaller units, which could be more rapidly frozen, would be revolutionary, but by no means inconceivable.

If the chilling alternative is followed, attention must be concentrated on the problems of controlling temperature and humidity to a much higher pitch of accuracy, and in the first place, scientifically conducted temperature and humidity surveys under existing conditions of "chilled" beef transport are called for.

Ice-free Chilled Beef.

Such beef is much desired, because it approximates most closely to the home killed product. It gives no drip. It retains its flavour. It does not sweat so much when removed to ordinary temperatures. Its "bloom" is better preserved, and changes due to the action of deposited water on exposed fat are minimised. The conditions necessary for the transport of ice-free chilled beef are one of the major problems to-day. There are two parts to the problem: to define the conditions of cooling, humidity, air circulation which will control mould growth; to obtain these conditions when carcasses are hung in bulk in such a way as to utilise as little space as possible.

Conclusion.

While of necessity omitting many aspects, it has been my object in these lectures to give a bird's-eye view of the subject of Refrigeration from the biological point of view, with especial reference to food preservation. In passing, I have been concerned to show how closely fundamental studies of the nature and properties of food products dovetail with practical applications in the industry. The substance of most of the ground covered is provided by the work of the scientific staff of the Food Investigation Board of the Department of Scientific and Industrial Research begun and carried out during the past ten years under the inspiration and leadership of my chief, Sir William Hardy, F.R.S.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings, at 8 o'clock.

February 13.—Cecil Hooper, F.L.S., "The Pollination of Fruit Blossoms in relation to Commercial Fruit Growing." H. V. Taylor, Esq., A.R.C.S., B.Sc., O.B.E., will preside.

February 20.—James Morton (of Morton Sundour Fabrics, Ltd.), "The History of the Development of Fast Dyeing and Dyes." Professor Henry E. Armstrong, LL.D., Ph.D., F.R.S., will preside.

February 27.—A. F. Suter, "East Indian Copals and Damars."

March 6.—Tom Purvis, "Commercial Art." Percy V. Bradshaw, will preside.

March 13.—R. P. G. Denman, A.M.I.E.E. (of the Science Museum, South Kensington), "Loud Speakers." William Henry Eccles, D.Sc., F.R.S., will preside.

March 20.—Professor A. E. Richardson, F.R.I.B.A., "Modern English Architecture."

April 10.—G. H. Nash, C.B.E., European Chief Engineer, International Standard Electric Corporation. "A Brief Review of Speech Communication by Electric Methods."

Dates to be hereafter announced :—

P. Morley Horder, F.S.A., "Architectural Models."

Sir Gerald Bellhouse, C.B.E., H.M. Chief Inspector of Factories, Home Office, "Safety in Factories."

J. F. Crowley, D.Sc., B.A., M.I.E.E., "Recent Developments in Vegetable Oil Extraction."

Lady Inglefield, "Lace."

Charles J. Ffoulkes, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts."

Major T. H. Bishop, M.R.C.S., L.R.C.P., D.P.H., "The Purification of Water."

Indian Section.

Friday afternoons, at 4.30 o'clock.

March 8.—W. H. Moreland, C.S.I., C.I.E., "The Indian Peasant in History: an Introduction to the Linlithgow Report." Sir Edward D. Maclagan, K.C.S.I., K.C.I.E., will preside.

April 12.—A. T. Cooper, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

May 10.—P. Johnston-Saint, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.)

Dominions and Colonies Section.

Tuesday afternoons, at 4.30 o'clock.

February 26.—Dr. H. J. van der Byl, Chairman, South African Iron and Steel Industrial Corporation, Ltd., "The South African Iron and Steel Industry." Sir William J. Larke, K.B.E., Director, National Federation of Iron and Steel Manufacturers, will preside.

March 26.—H. Warington Smyth, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa."

Shaw Lectures.

Monday evenings, at 8 o'clock.

Sir Thomas Morrison Legge, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, "Thirty Years' Experience of Industrial Maladies."

Three lectures: February 18, 25, and March 4.

Lecture I.—The "Looks" of the People. Advantages of a disengaged eye occasionally in the Factory—A help in determining success or otherwise of Welfare arrangements—Classification of "looks" in women—Results—Difficulty of classifying "looks" in men owing to the interest excited by the absorbing nature of their work—Australian men of a pre-eminently handsome type.

Lecture II.—Thirty Years' Experience of the Notification of Industrial Diseases. The eleven notifiable diseases and forms of poisoning—Results obtained in disappearance of some, diminution of others and stationary conditions of yet others again—Reasons for this in the remedial measures applied—Dominance of lead poisoning, anthrax and skin cancer.

Lecture III.—Twenty Years' Experience of Compensation for Industrial Diseases. The wide net of the Compensation Act—Twenty-eight diseases and forms of poisoning scheduled—Reasons for exclusion of some—Results obtained as shown in the chart—Dominance of miners' maladies—Increase in dermatitis—Increasing importance of silicosis and help given by the action of the South African Government in dealing with it.

Cantor Lectures.

Monday evenings, at 8 o'clock.

Sir E. Denison Ross, C.I.E., Ph.D., "Nomadic movements in Asia." Four Lectures: April 15, 22, 29, and May 6.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, February 11..African Society, at the Royal Society of Arts, Adelphi, W.C. 5 p.m. Mr. T. A. Barns, "Through Portuguese West Africa."

Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Brewing, Institute of, at the Charing Cross Station Hotel, Strand, W.C. 7.45 p.m. Dr. S. B. Schryver, "The Proteins and their Importance in Brewing Theory and Practice."

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr. Frank Birdwood, "The Indian Coastal Traffic Bill."

Electrical Association for Women, at 15, Savoy Street, W.C. 7 p.m. Mr. H. de A. Donisthorpe, "Radio Progress and its Connection with the Thermionic Valve."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Geographical Society, at Lowther Lodge, Kensington Gore, S.W. 5 p.m. Captain E. R. L. Peake, "The Tavistock Theodolite."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. G. S. Szlumper, "Cross Channel Traffic Working."

University of London, at University College, Gower Street, W.C. 2 p.m. Miss M. St. Clair Byrne, "Elizabethan England."

5 p.m. Dr W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture II.)

5.30 p.m. Prof J. G. Andersson, "Archæological Research in China." (Lecture I.)

5.30 p.m. Dr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture I.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture V.)

Tuesday, February 12. Asiatic Society, 74, Grosvenor Street, S.W. 4 p.m. Dr. L. D. Barnett, "The Genius: A Study in Indo-European Psychology."

Automobile Engineers, Institution of, at the Rover Sports Club, Coventry. 7.30 p.m. Dr. F. W. Lanchester, "Coil Ignition."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

At the Royal Technical College, Glasgow. 7.30 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Empire Society, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Percy Cox, "Iraq."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. Mr. G. J. Scott, "The Design and Construction of Electric Auxiliaries for Marine Service."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. J. E. Newson, "Metallurgy of Engineering."

North East Coast, Institution of Engineers and Shipbuilders, at Cleveland Institute, Middlesbrough. 7.30 p.m. Mr. G. B. Butler, "The Manufacture of Steel as Applied to Shipbuilding and Engineering."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Messrs. J. S. Parker and C. A. P. Southwell, "Chemical

Investigation of Trinidad Well Waters and its Geological and Economic Significance."

Philosophical Studies, Institute of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8.15 p.m. L. Susan Stebbing, "Is 'Good' Objective?"

Quekett Microscopical Club, 11, Chandos Street, W. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture III.)

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture V.)
5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Motors."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Mr. F. L. Engledow, "Plant Breeding." (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Dr. G. M. Morant, "The Current Work of the Biometric and Eugenics Laboratories." (Lecture III.)
8.15 p.m. Miss E. Jeffries Davis, "Historical Factors of the Problem of London Traffic." (Lecture II.)

WEDNESDAY, FEBRUARY 13.. Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. P. Gaze, "Merits of Alternative Methods of Driving Auxiliaries in Modern Power Stations."

Fuel, Institute of, Burlington House, W. 6 p.m. Mr. W. F. Goodrich, "Fuel Economy and the Small Steam User."

Heating and Ventilating Engineers, Institution of, at the Holborn Restaurant, W.C. 2.30 p.m. Ordinary Meeting. Mr. H. G. Cathcart, "Water Softening by the Base Exchange Process."

Mechanical Engineers, Institution of, at the Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture.)

Metals, Institute of, at Thomas' Café, Swansea. 7 p.m. Mr. J. E. Malam, "Recent Developments in Rolling Metal Strip and Sheet."

North-East Coast, Institution of Engineers and Shipbuilders, at Belbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. F. H. Todd, "Ship Trials and their Analysis."

United Service Institution, Whitehall, S.W. 3 p.m. Mr. J. M. Keynes, "National Finance in War."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. W. J. Constable, "English Painting."
5.30 p.m. Prince D. Svyatopolk, "Contemporary Russian Literature, 1917-1928." (Lecture V.)
(London School of Economics), at Chesham House, 136, Regent Street, W. 6 p.m. Mr. R. Horrocks, "Nominal Ledgers and Managerial Statements."
At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture IV.)
5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture V.)
5.30 p.m. Prof. J. G. Anderson, "Archæological Research in China." (Lecture II.)
5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture II.)
5.30 p.m. Mr. B. M. Headicar, "A Bibliography of Political Economy, Methods of Construction and Plans for keeping up-to-date."

THURSDAY, FEBRUARY 14. Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.45 p.m. Mr. A. H. R. Fedden, "Air-Cooled Engines in Service." (Joint Meeting with Institution of Automobile Engineers.)

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. W. Cruickshank, "Voice-Frequency Telegraphs."
At University College, Dundee. 7.30 p.m. Mr. W. B. Woodhouse, "Overhead Electric Lines."

Historical Society, 22, Russell Square, W.C. 5 p.m. Anniversary Meeting.

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Shoreditch, E. 7.30 p.m. Mr. A. Stratton, "Tudor Houses."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture.)

Metals, Institute of, at 83, Pall Mall, S.W. ...

(3) Mr. H. Wrighton, "High Magnification Microscopy"; (4) Mr. W. E. Prytherch, "Dilatometers"; (5) Mr. A. J. Murphy, "Preparation of some Unusual Metallographic Specimens."

Metals, Institute of, at 39, Elmbank Crescent, Glasgow. 7.30 p.m. Dr. W. Rosenhain, "Alloys: Past, Present and Future."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Sir William Bragg, "The Early History of X-Rays. Lecture III.)

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. "Architecture and its Relation to National Life—(Lecture V) on "Egyptian Architecture."
At King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture I.)
5.30 p.m. Mr. Ifor Evans, "Czechoslovakia" (Lecture V) "The Economic and Financial Problems of the Republic."
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski," Renaissance Poland."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Mr. F. L. Engledow, "Plant Breeding." (Lecture II.)
At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture IV.)
5 p.m. Mr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture V.)
5.15 p.m. Prof. J. E. G. de Montmorency, "The Barbarian Codes of Hither Europe, A.D. 450-850." (Lecture III.)

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Prof. F. W. Hudig, "Delft Pottery."

FRIDAY, FEBRUARY 15.. Electrical Development Association, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. H. W. Roberts, "Organising for Increased Sales—Spring Cleaning Season, 1929."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Lt.-Colonel Vaughan-Morgan, "Open Spaces and Playing Fields for London."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Annual General Meeting. Mr. H. J. Ward, "Refrigeration on Shipboard."

Oil and Colour Chemists' Association, at Milton Hall, Manchester, 7.30 p.m. Mr. F. Scholefield, "Ostwald's Colour System."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Dr. Eric K. Rideal, "Chemiluminescence."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. C. Douglas Campbell, "Inland Water Transport."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Henry Thomas, "The Pass, the Battle and the Monastery of Roncevaux."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. C. E. R. Sherrington, "Motor Transport and the Urbanisation of the Countryside."
At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture V.)
5.30 p.m. Prof. J. G. Anderson, "Archæological Research in China." (Lecture III.)
5.30 p.m. Mr. Geoffrey Peto, "The Local Government Reform Scheme and De-Rating."

SATURDAY, FEBRUARY 16.. L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss I. D. Thornley, "Travel and Travellers in the Middle Ages."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Bullock, "Music in Cathedral and Collegiate Churches. (Lecture II.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3978. VOL. LXXVII.

FRIDAY, FEBRUARY 15th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 18th, at 8 p.m. (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, "Thirty Years' Experience of Industrial Maladies." (Lecture I.)

WEDNESDAY, FEBRUARY 20th, at 8 p.m. (Ordinary Meeting.) JAMES MORTON (of Morton Sundour Fabrics, Ltd.), "The History of the Development of Fast Dyeing and Dyes." PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., will preside.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting in connexion with the Fund for the Preservation of Ancient Cottages will be held in the Hall of the Royal Society of Arts on Wednesday, February 27th, at 3 p.m. THE RT. HON. J. RAMSAY MACDONALD, M.P., will preside, and the speakers will include MR. G. K. CHESTERTON, LIEUT-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., SIR GEORGE SUTTON, BT., Chairman of the Council, and others.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

COMPETITION OF INDUSTRIAL DESIGNS.

The sixth annual Open Competition of Industrial Designs will be held in June next, and full particulars can now be obtained on application to the Secretary of the Royal Society of Arts.

Over £2,000 will be offered in prizes and scholarships in the various sections, distributed as follows :—Architectural Decoration, £365 15s. ; Textiles, £704; Furniture, £145 ; Book Production, £73 10s. ; Pottery and Glass, £52 10s. ;

Advertising (Posters, Showcards, etc.), £699 2s. The Art Congress Studentship, of the value of £50, is also offered and may be awarded at the discretion of the Judges in any section of the competition.

After the work has been judged a number of selected designs will be exhibited in London, and subsequently at suitable centres in the provinces. In this way they will be brought immediately to the notice of those manufacturers who are likely to be specially interested in them.

It is intended to confer the Society's Diploma on any candidate whose work reaches a very high standard of artistic ability and also shows practical knowledge of the materials and processes of his trade.

A Bureau of Information has been established at the Royal Society of Arts for the registration of the names and addresses of exhibitors who desire to obtain employment as designers. These lists are at the service of manufacturers in search of designers.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 6th, 1929. E. F. C. TRENCH, ESQ., C.B.E., M.Inst.C.E., Consulting Engineer to the L.M. & S. Railway, in the Chair.

The Trueman Wood Lecture was delivered by SIR J. ALFRED EWING, K.C.B., LL.D., D.Sc., F.R.S., M.Inst.C.E., Principal and Vice-Chancellor of the University of Edinburgh and Chairman of the Bridge Stress Committee, on "The Vibration of Railway Bridges: An Example of Co-operative Research." The lecture will be published in the *Journal* on March 15th.

INDIAN SECTION.

FRIDAY, FEBRUARY 8th, 1929. VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, late Commander-in-Chief, East Indies Squadron, in the Chair.

A paper on "The History of the Indian Marine" was read by CAPTAIN SIR EDWARD J. HEADLAM, C.S.I., C.M.G., D.S.O., R.I.M., late Director the Royal Indian Marine. The paper and discussion will be published in the *Journal* dated March 22nd.

CANTOR LECTURES.

The Cantor Lectures on "Acoustics," by Mr. A. G. Huntley, of the May Construction Company, Ltd., are available in pamphlet form (price 2s. 6d.), and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can also be had on application.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

WEDNESDAY, 16th JANUARY, 1929.

DR. MARGARET FISHENDEN, D.Sc., F.Inst.P. (Fuel Research Division, Department of Scientific and Industrial Research), in the Chair.

THE CHAIRMAN, in introducing the lecturer, said that Professor Darling was going to speak on a problem which very few, in this industrial age, were fortunate enough to be able to avoid, namely, smoke. There were many objections to smoke, but perhaps the strongest one was that it was so unpleasant. For that reason alone any suggestions Professor Darling might have to put forward would be listened to with attention.

The following paper was then read:—

THE DOMESTIC SMOKE PROBLEM—A PRACTICAL SOLUTION.

By PROFESSOR CHARLES R. DARLING, A.R.C.Sc.I., F.I.C., F.INST.P.

The smoky atmosphere of London has been a reproach for centuries. Writers from the time of Queen Elizabeth have vied with each other in describing the evil effects of smoke on the health of the inhabitants and on buildings, but it is only in recent years that any mitigation of the nuisance has been witnessed. This improvement has been due to two chief causes—the adoption of more efficient furnaces for manufacturing purposes and the introduction of smokeless appliances for domestic use, such as gas fires, electric radiators, anthracite stoves and coke-fired boilers. It is estimated that five-sixths of the smoke discharged into the atmosphere of London is of domestic origin, and it therefore follows that the prevention of smoke is mainly a domestic problem. Yet, in spite of all the contrivances named, the output of smoke is almost as great as ever. During the last ten years upwards of 180,000 new houses have been erected in the metropolitan area, each being a potential producer of smoke. The consumption of coal for household purposes in the London area is estimated at eight million tons per annum, only a small percentage of which is represented by anthracite or smokeless coal. The same state of things prevails in other large centres of population throughout the country—new houses and more smoke—the total consumption of household coal being about thirty-six million tons per annum.

In trying to find a remedy it is first of all necessary to enquire into the reasons why household coal is still so extensively used, although domestic appliances for producing heat without smoke have been available for many years. The two chief reasons are that hitherto no alternative to the coal fire has been discovered at once so cheap and generally useful, and, secondly, even in cases

where the question of cost may be discarded, there is an ingrained preference on the part of the average person for an open coal fire, which gives to a room a sense of comfort and cheerfulness. In the latter connection it is interesting to note that modern hotels, fitted with central-heating apparatus and all the latest devices, advertise " a coal fire in the lounge." G. K. Chesterton describes the coal fire as " the veritable flame of England, still kept burning in the midst of a mean civilisation of stoves." The only hope of curing the smoke nuisance lies in the production of a substitute which, whilst retaining all these desirable features, does not give rise to smoke and is as cheap or cheaper to maintain. It is the purpose of the present Paper to endeavour to show that such an alternative is to hand and that the domestic smoke problem may definitely be solved.

Before entering into the question of remedies it is necessary to consider the part played by the coal fire in the homes of different sections of the community. A very large proportion of the dwelling-houses in large centres of population are small, containing five to eight rooms, and the occupants in most cases cannot afford to use heating devices which are costly to buy or maintain. In the smallest of these the kitchen is frequently the living room, and the coal fire, in addition to warming the room, is used for heating water, cooking, and other domestic operations, including the drying of the family washing in wet weather. Domestic refuse is—or should be—burnt on it, and it is this general utility, combined with cheapness, which explains its continued use in spite of rivals. In the seven or eight-roomed house the " reception " room usually occupied contains a coal fire for the reasons of economy, comfort and ventilation ; and in this case also alternative methods have not been adopted to any great extent. In houses larger than these a little luxury in the way of heating can generally be afforded, and one or other of the various smokeless devices will be found in use in some part of the house, but it is seldom that the coal fire is entirely absent. Our problem, then, is to provide a heating device which may replace the coal fire in all these different types of homes, remembering that in most cases any addition to the weekly budget would be a fatal drawback.

As the question of cost is of such vital importance, it will be of value to examine the various methods of domestic heating from this point of view. The accompanying table has been prepared, in the case of fuels, from the actual costs as delivered in South-east London; the figure for electricity is hypothetical. In other localities, where costs are different, the figures will require amendment accordingly. The usual calorific values have been assumed.

It is not intended here to enter into the question of the efficiencies of apparatus in which the foregoing sources of heat are employed, as these vary so greatly according to the conditions of use. It is cheaper, for example, to use an electric radiator or gas fire in a room which will be occupied for a short time only rather than to light a coal fire. The conclusion to be drawn from the

Source of Heat.	Cost.	British Thermal Units for 1 penny
Gas Coke	37s. per ton	60,000
Household Coal ..	48s. ,, ,,	57,000
Low Temperature Carbonisation Coke	52s. ,, ,,	45,000
Anthracite Coal ..	69s. ,, ,,	40,000
Coal Gas	8¾d. per therm	11,400
Oil for oil stoves ..	1s. 2d. per gallon	11,400
Electricity ..	1d. per unit (kilowatt hour)	3,415

figures is that for continuous burning solid fuels are much cheaper 1 materials or methods, and that the solution of the smoke problen sought on lines involving the use of a smokeless, solid fuel. The p of each kind will now be considered.

Attempts to use coke for open fireplaces date back for more t centuries. In 1626 Sir John Hacket and Octavius de Strada obtaine for converting coal into coke, " in order to make it as pleasant a chambers as wood or charcoal." The project was soon abandone was not until after the commencement of the manufacture of coal gas coke appeared as a by-product, that any serious trials were made wi to using gas coke in open fires. It was found to be difficult to ignite to give a dull fire in the open grates generally in use in the last centu was commonly believed that gas coke was unsuitable for open fires arose the idea of low-temperature carbonisation, by means of which a with properties half-way between coal and coke could be procured whi burn without smoke in existing fireplaces. It is only during the last that scientific work has been carried out with a view to modifying the so that gas coke could be burnt satisfactorily. In this connection Vernon Boys was the first to call attention to the effect of thermal conc on the combustion of fuels in an open fireplace. If an isolated piece be lighted at one corner it does not continue to burn, because the loss by radiation and conduction through the coal lowers the temperatu the point of ignition. In lighting a coal fire it is necessary to ignite area of surface in order that the coal may maintain itself above the ignition by the heat given out, and only then will combustion procee temperature attained will depend upon the rate of burning, which in t be influenced by surrounding conditions ; a piece of coal, for example is in contact with the iron cheeks of a fireplace will only burn on its in owing largely to the cooling effect of the iron. Gas coke, which is or more difficult to burn than coal, is greatly affected by contact with m metal in the fireplace and with the small draught existing only burns l

in the centre of the fire. Boys showed, however, that in a fireplace lined throughout with firebrick coke would attain a much higher temperature than when masses of metal were in contact with it. Further modifications were needed, however, before the coke fire could really be pronounced satisfactory; and in a paper read before this Society on March 9th, 1927, by Dr. E. W. Smith, several types of open grates for burning gas coke are referred to. Some weeks

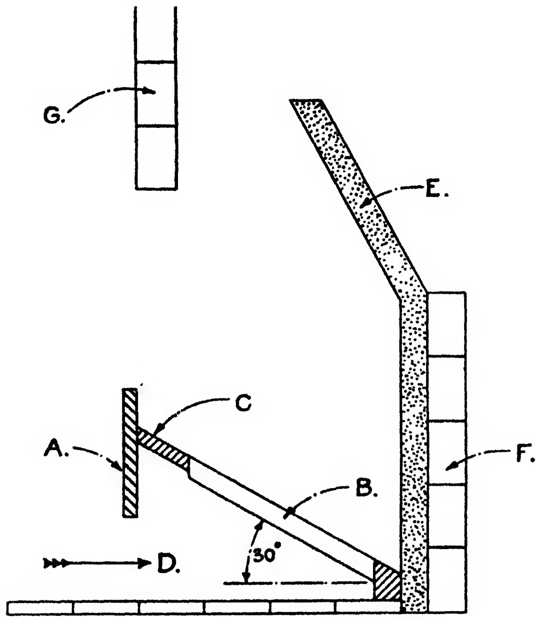


FIG. 1.

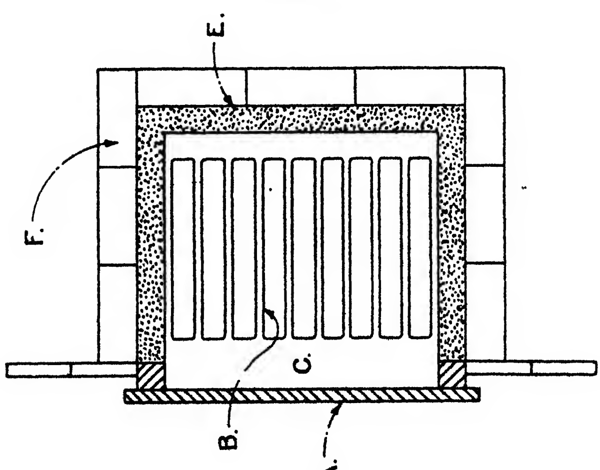


FIG. 2.

before Dr. Smith's paper was read the present writer had been trying an open coke fireplace installed by the South Metropolitan Gas Company, and his early experiences were described in the discussion which followed the reading of the paper (*Journal* R.S.A., May 6th, 1927). This trial has now extended over a period of two years, and a description of the fireplace and an account of its performance should be of interest.

The construction of this fireplace is shown in Figs. 1 and 2, the former being a sectional elevation and the latter a plan. The novel feature is the slope of the firebars, *B*, which are inclined at an angle of approximately 30° to the horizontal from front to back. As seen in the plan, the firebars are widely spaced so as to permit of an adequate air supply for combustion. At the upper

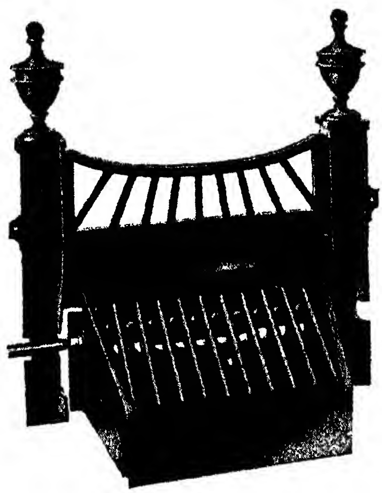


FIG. 3.

end the firebars are connected to a dead-plate *C*, which forms a part of the front of the grate. The sides and back of the fireplace are lined with firebrick *E*, which is backed by insulating bricks *F*. A gas burner (not shown in the drawings) is located at *D* and is provided with jets opposite to the spaces between the firebars, protected from falling dust by the dead-plate *C*. Fig. 3 is a reverse view of the grate and shows clearly the arrangement of the firebars and jets. To start the fire ordinary broken coke of size from 2 inches to ¾ inch is put into the fireplace and the gas jets ignited. After about 15 minutes the jets are extinguished and the fire is then established. The combustion increases in vigour until the coke attains a bright white heat and is accompanied by flames which add to the pleasing appearance of the fire.

No attempt has been made by the present writer to test this fire with scientific appliances on the lines adopted by Dr. Margaret Fishenden in her researches on domestic fuels, as such tests require special apparatus and continuous

observation. Actual figures as to the quantity of heat radiated into the room cannot therefore be given, but as the fire is somewhat hotter than one in which semi-coke is burnt in an ordinary grate of good design, it is safe to assume that more than 30 per cent. of the heat of the coke is thus given to the room. The highest figure obtained by Dr. Fishenden for cakes of semi-coke was 30.8 per cent. (Fuel Research Board, Technical Paper No. 3), and for coal 24.2 per cent.; so that in the gas coke fire under notice 35 per cent. would probably not be an over-estimate. In the present case, however, it was thought better to test the fire under ordinary household conditions of use and to compare the costs with those of a corresponding coal fire. As the result of two years' use in all types of weather, it has been found that the temperature of the room can be maintained by a consumption of gas coke not exceeding in weight the coal

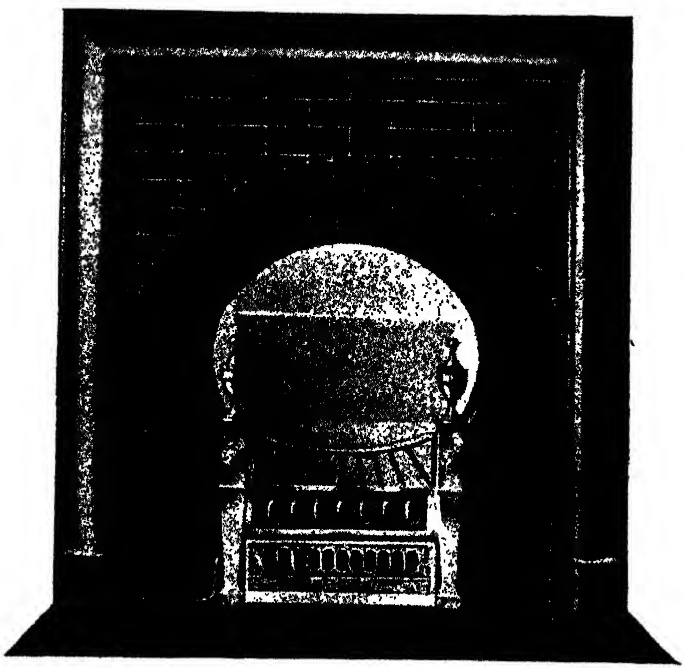


Fig 4.

required in an equivalent fire. The financial saving in fuel is therefore represented by the difference in price between coke and coal, which varies with the locality and according to the figures given earlier in the paper amounts to about 25 per cent. In addition to less fuel costs, however, the fire has many other advantages. It dispenses with the use of sticks and paper, and owing to the dead-plate *C*, no ashes can drop out in front of the fire, but are all collected in an ashpan below and are easy to remove. The temperature can be regulated by passing a poker between the firebars, although the downward

slope of the bars renders the fire partially self-cleaning, as when the fuel contracts on burning the coke in front slides down and adhering ash is loosened and falls through the spaces. The temperature is never so great as to form clinker or to cause fusion of the firebrick. The easy and largely automatic removal of ash, combined with good thermal insulation, are the special features which enable gas coke to be burnt so as to produce a fire superior in every respect to the ordinary coal fire and at a smaller cost. The actual appearance of the grate in shown in Fig. 4.

Let us now consider whether a fire of this kind can be applied to the smallest homes so as to replace the coal fires generally in use. As a kitchen fire in a five or six-roomed house this arrangement, which will enable cooking operations, heating of flat-irons, etc., to be carried out, is quite simple and more efficient than in the case of the coal fire, in addition to being cleaner and cheaper in use. The cost of the gas used in ignition is counterbalanced by the saving in fire-

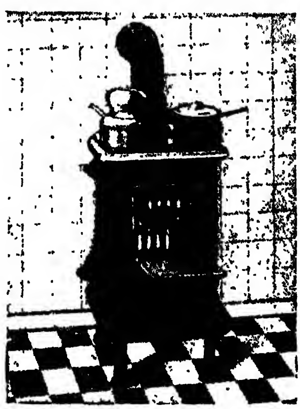


FIG. 5.

wood and the fees of the chimney sweep. In new houses the coke fireplace could be installed at a cost little greater than that of the ordinary grates; in existing houses the cost of replacement is not great, and would be recovered by the saving in fuel. Similarly, in seven or eight-roomed houses the sitting-room fireplace could be made initially to burn coke or existing grates easily modified to this end. In larger houses in which the occupants could without difficulty afford the outlay, it would be an advantage to replace all existing coal fires by arrangements for burning gas coke, giving a cleaner home and yet losing none of the advantages of the coal fire.

To avoid misunderstanding the writer wishes it to be known that he has no financial interest in the fireplace described, and would add that any other contrivance for burning gas coke which fulfilled the same requirements would be of equal value if equally cheap and simple. For kitchen use in small homes hot-water boilers are now made which can be converted into open fires when desired, and on the hot top of which a certain amount of cooking can be con-

ducted; and if designed to burn gas coke and to work economically will be preferred by many to the open coke fireplace. An example is illustrated in Fig. 5, which represents an open-fire kitchen boiler made by the Beeston Boiler Company. Both this and the fire previously described are capable of burning domestic refuse.

Assuming, then, that in all fires coal could be replaced by gas coke, the domestic smoke nuisance would appear to admit of an easy solution, accompanied by the further advantage of reducing the fuel bills of the consumer. Unfortunately, the amount of gas coke available for domestic use is quite inadequate to supply what would then be needed for household purposes. The total production of gas coke throughout the country is roughly 12,000,000 tons, of which more than 3,000,000 tons are used for heating retorts, etc., in the works. About 2,000,000 tons of the remainder are either converted into water gas or exported; but, even if the latter quantity were used instead for domestic purposes, the total supply would only be 9,000,000 tons, as compared with a coal consumption of 36,000,000 tons. In London the corresponding figures would be about 3,000,000 tons of coke and 8,000,000 of coal. Evidently, therefore, further supplies of suitable fuel from some other source are essential if the domestic smoke problem is to be solved completely. An obvious method of obtaining larger quantities is to carbonise more coal, but this can only be done on an economic basis. In recent years much research on the carbonisation of coal at low temperatures has been carried out, and many projects have been launched with a view to placing the process on a commercial basis. The aim in many cases has been to obtain a high yield of oils and other valuable by-products and to procure a solid residue of light coke, which would burn in an ordinary domestic fireplace. The question of the future success or otherwise of low temperature carbonisation does not arise here except so far as the solid residue is concerned. This, in order to compete with gas coke, must be sold at as low a price. The fact that gas coke can now be used in the open fireplace completely alters the outlook, and there is now no need for a semi-coke, less durable and occupying more cellar space than gas coke, in the domestic circle. A treatment of coal which gave the necessary yield of oils, etc., and left a residue of the nature of gas coke, if economically sound with regard to the disposal of the by-products and gas produced, would effectively solve the problem of the shortage of smokeless solid fuel. It is earnestly to be hoped that the intensive research which is being conducted will result in the perfection of a process of this kind, as, in addition to providing smokeless solid fuel, it should lead to a greater consumption of gas and aid in this way also to prevent the production of smoke.

Apart from coke, the only other solid smokeless fuel obtainable in large quantities is anthracite coal. This fuel may be burnt with moderate success in an ordinary open fireplace, but is difficult to ignite. Burnt in the gas coke grate, using a gas-flame igniter, anthracite is an ideal fuel with only one drawback—its

high cost. The best size to employ is that known in the trade as "French nuts," which are about 2 inches in maximum and 1 inch in minimum dimension. The anthracite ignites rather more readily than gas coke and gives a more enduring fire, the appearance of which leaves nothing to be desired. Comparative tests over a short period indicate that about 3 pounds of anthracite are equal to 4 pounds of coke, and if prices were in the same ratio anthracite would be preferable on account of its smaller content of ash. To compete with coke at 37s. per ton the price of anthracite should not exceed 50s. per ton, but in London the cost is about 20s. per ton above the competitive figure. Whether on the basis of larger sales and increased economy in production the cost of anthracite to the consumer can be reduced sufficiently to compete with gas coke is a matter which the interests concerned might do well to consider. Cheap anthracite would complete the solution of the smoke problem ; and in homes in which a little luxury in the matter of fires is permissible an anthracite fire in a suitable grate will be found to be cleaner and of better appearance than an ordinary coal fire. Now that gas coke and anthracite can be burnt to such advantage in an open fireplace without sacrificing any of the amenities of the ordinary coal fire, there is no reason why smoke should any longer be produced in large houses, clubs, or hotels. But we must always keep in mind that the domestic smoke problem is one which mainly concerns the small homes, in which cost is a vital factor.

So far we have only considered solid fuels burning in an open fireplace, and the question of alternative methods now arises. Had it not been for the extensive use of gas fires and cooking stoves, electric radiators, ovens and other contrivances ; hot-water boilers and radiators ; closed anthracite stoves, and, to some extent, oil stoves, the smoke nuisance would have been much worse than it is at present. Those who can afford to use these appliances without troubling about cost will be well advised to do so ; but their application in small homes is limited by the question of finance. When the national scheme for the distribution of cheap electricity comes into operation, we may reasonably expect to procure current at one penny per unit for heating purposes, and at this price even the smallest homes might with advantage have a few electric appliances. Although the solid fuel fire is the cheapest for continuous use, its advantages disappear when the heat is required only for a short time ; and the complete equipment of any house should include arrangements for occasional as distinct from continuous heating. Taking the case of a five or six-roomed house, a gas cooking stove should be installed as the cheapest means of preparing food in cases when the kitchen fire is out of use—e.g., early in the morning and in hot weather—or when it does not possess an oven. Heating arrangements should be provided for the bedrooms, one of which should be a grate for solid fuel, to allow for prolonged occupation in case of sickness ; other bedrooms should be fitted with gas fires or wired for an electric radiator. Oil stoves may also be used for occasional heating if the room is well ventilated, the colourless

flame type being preferable. Hot water should be procurable by means of a chimney boiler in the kitchen fireplace, or, alternatively, the combined boiler and fire as shown in Fig. 5, may be used. In the seven or eight-roomed house the same scheme should still apply, an electric radiator being used in the sitting room when the fire is not lighted and a little heating is desirable. In this manner, and without any increase in weekly costs, all these houses can be made smokeless. Houses larger than these, in which a little luxury in heating can be afforded, may be fitted with hot-water boilers and radiators, gas or electric cookers, gas fires or electric radiators, or any of the many contrivances now on the market, according to the means and preferences of the occupiers.

In conclusion, we may consider the definite plan of action to be followed to abolish domestic smoke, having regard to existing and future conditions. Firstly, remove the ordinary coal fire from the designs of all new houses, of whatever size, putting in its place a smokeless fireplace, thus securing that no further additions to the smoke shall be made. This is a matter which specially concerns local building authorities and medical officers of health, who should use their full powers to secure this change. Secondly, efforts should be made to induce landlords and tenants of existing houses to convert the grates at present used for burning coal into the smokeless variety. Although this would entail a small outlay, the cost would be recovered later by the saving in fuel effected, and an arrangement might be made between landlord and tenant so that neither would suffer financially. . Here again local authorites and medical officers of health can do much to bring about this desirable change. The rate of progress will depend upon the efforts made, but a persistent campaign is bound to lead to a notable reduction of smoke in a short time. By the time the consumption of gas coke has caught up to the present supply we may reasonably expect suitable fuel from other sources, such as modified processes of low temperature carbonisation which give an end-product of coke of the same nature as gas coke. Incidentally, the production of this extra supply of coke would greatly increase the quantity of coal gas available and by reducing its cost greatly extend its use for household and power purposes. Alternatively, a large use of anthracite might make it possible to reduce its present price by a sufficient margin to bring it into competition with gas coke. If the plan suggested were followed, before many years were over domestic smoke should become a dark dream of the past. The only sufferer would be the chimney sweep, whose occupation would be gone.

DISCUSSION.

The Chairman, in opening the discussion, said the lecturer had put forward very practical and definite suggestions for combatting the smoke nuisance. A certain amount of progress had already been made, mainly through the agency of gas; but the enormous quantity of raw coal still used for domestic purposes in this country was evidence of how much still remained to be done. Including

miners' coal, this amounted to 40,000,000 tons annually and represented nearly one-fourth of the total consumption for all purposes. Not only was it a very high figure, but since domestic coal was burned in a far more inefficient manner than industrial coal, it threw out smoke out of all proportion to its bulk. Further, the smoke was of a tarry, sticky nature, and was in consequence more harmful than industrial smoke. Much of the prejudice against gas coke was without foundation. There were of course certain uses of gas coke which were considered to be more or less legitimate. It was for instance, well known to be a suitable fuel for independent boilers or for the small boilers of central heating installations, and there was also evidence to show that coke compared favourably with coal for big scale boiler work; but what she was now referring to was the use of coke for ordinary domestic purposes. Gas coke of reasonably good quality would burn satisfactorily in many open grates. Certain conditions had of course to be fulfilled. For instance, the grate should be well insulated; it should have a fairly deep bed of fuel, and there should be good draught control, since there might be a tendency for coke, which was a non-caking fuel, to burn too fast when combustion got well established. There remained the difficulties of ash disposal, and of ignition; but if a grate embodied all the features mentioned, and if a gas fire-lighter with ample consumption were available, she was inclined to agree with the lecturer that ignitibility might not be the essential feature to be sought. In such circumstances the criteria of a really good domestic coke would probably rather be low ash and moisture content, for under such conditions it was possible to light and burn not only gas coke but harder cokes still.

The lecturer would be interested to know that at the Fuel Research Station there was now in progress a systematic investigation both of cokes, and of grates for burning cokes. They had been working in the first instance mainly from the point of view of how easily a coke could be lighted—not because they thought that was the only thing that mattered, but because they believed it was one very important thing, since, after all, practically the whole of the 40,000,000 tons of domestic coal was burned in grates that had not gas fire-lighters installed. It might be interesting to remark that low temperature cokes could be brought, after consumption of only 2 or 3 cubic feet of gas, to a stage when they would support independent combustion. Even for gas cokes 4 or 5 cubic feet of gas was sufficient. They had been able to light hard metallurgical coke by giving it enough gas and had obtained extremely good fires from it. If a gas fire lighter were available it would not matter much whether one burned 5 or 10 cubic feet. There were still, however, a great number of cases where ease of ignition was of considerable importance. From that point of view undoubtedly low temperature cokes scored. They could be lighted by the methods to which the ordinary housewife was accustomed, were more rapidly controlled than gas coke, and could be used in existing types of grates. One thing, however, should be remembered, namely, that low temperature cokes were subject to variation, just like ordinary gas coke, according to the coal from which they were made. They might be disagreeable fuels if they contained too much ash. She was not of the opinion that the exact efficiency attained was of very much consequence beyond a point. It was known that on the whole coke was rather more efficient than coal, and she did not think an extra 1 or 2 per cent. efficiency would count very much against convenience. A very large quantity of coke would be wanted if any real mark was to be made on domestic smoke, and a point of real importance was the disposal of the other products, unless we were going to embark on schemes of complete gasification. Whatever type of coke were adopted it would be necessary very considerably to enlarge the present works, and from that point of view the fact that gas coke was already available was not a strong argument, because new plant would, in any case,

have to be put up if the demand increased very much. Such plant could be designed for making either low or high temperature coke as desired, but it was possible that in either case the gas industry, which was accustomed to deal with sales of carbonisation products, would be the most suitable to exploit it. If gas coke were used it would be necessary also to dispose of the gas and it had even been suggested that a time might come when gas would be used to heat the retorts, owing to the increased demand for coke.

She was not quite so optimistic as the lecturer in thinking that the problem was entirely solved when a coke was found which would burn in sitting room grates, or even in kitchen ranges. It was necessary to point out that it was not enough for a coke to burn; it must also do its job, and although coke was quite satisfactory in kitchen ranges for hot water production, it sometimes failed to heat the oven. The gas cooker was an efficient appliance, and in some circumstances it paid to use gas for cooking. There were also many houses which needed to keep the kitchen fire going for general purposes and where it would be an extravagance to have a gas cooker in use as well. That was a real point, and one to which grate manufacturers should turn their attention.

The requirements of different types of households were very dissimilar, and the installation or equipment best suited for one house was quite different from that best suited for another. There was, therefore, room for a big expansion in the use of both gas and coke of various kinds. It was a pity anthracite was so dear but it had its uses and the solution of the smoke problem would most likely be found in a combination of the use of many different types of fuel.

She would like to ask the lecturer whether, in the grate which he had demonstrated and which did not appear to have any damper for closing the ingress of air below the fire, there was any difficulty from its over-rapid burning.

Mr. Ll. B. Atkinson (Past-President of the Institution of Electrical Engineers) said that for 40 years he had attended on every possible occasion any lecture which aimed at getting rid of the smoke nuisance of our great cities. He recalled the fact that it was in that very room about 40 years ago that Sir William Siemens had exhibited a coke fire with a gas igniter; why that appliance had died out he could not say. The lecturer had stated very fairly the case for the various fuels, but it seemed to him that, in discussing all the niceties of the comparative costs, the most important thing of all had been forgotten, namely, the enormous bill of ill-health which all had to pay by living in cities over which hung a perpetual pall of smoke, soot and dirt. Only within the last few years had people learned how largely their health depended on having ultra-violet light or short-wave radiation on them from above, but those things could not be obtained in cities like London with its pall of smoke. The fact was that people now had to put up with the smoke and to purchase some apparatus for the purpose of enjoying ultra-violet ray baths. If only people could get a full dose of sunshine through their city air, half their troubles would disappear. The smoke nuisance would never be cured until this country adopted the drastic cure which had been adopted by other countries, where there were alternative fuels,—namely, legislation which did not allow smoke. It would not, however, be fair to put such legislation into immediate effect in this country, because alternative fuels did not exist at the moment. We had to try, therefore, to discover those alternative fuels and to bring them into existence; and that was what the Research Board was trying to do. New York, for instance, did not allow smoke to be made. He remembered once walking down one of the main streets of New York and seeing some smoke. Knowing that no smoke was

allowed there he immediately thought that a fire was raging, and he went to a police officer to inform him. The officer, however, had said to him, " Do not be alarmed, or ring the fire alarm, as that is a baker's oven, and bakers are allowed to make smoke." He merely mentioned that in order to show that smoke was such a rare thing in New York that when a person saw it he immediately wanted to ring up the fire brigade under the impression that it was a fire. He was indebted to the lecturer for showing one way in which the disgraceful and dirty habit of burning raw fuel could be dispensed with.

Mr. A. H. Barker (Past-President of the Institution of Heating and Ventilating Engineers) remarked that when a man prevented smoke he did not prevent it for the benefit of himself so much as for the benefit of his neighbours; and when one invited a man to spend a considerable sum of money in order to get rid of smoke, one was inviting him to present something free of charge to his neighbours or to society at large. Human nature being what it was, the prospects of success in a matter of that kind were rather small. The only possible way in which the necessary reforms could be achieved was by legislation. So soon as a fuel could be provided which would enable people to obey such legislation, the time would have arrived at which to press for suppression of smoke. There was only one perfect way of reducing smoke under present conditions, and that was by increasing the use of gas. There was no reason, of which he knew, why a gas fire should not be made which was in most respects at least the equivalent of a coal fire. The main feature of such legislation would be the prohibition of the use of ordinary smoky coal. Unfortunately, however, it was the use of smoky coal which made the attractiveness of the coal fire. He could not blind himself to the fact that the appearance of a coal fire, with its flickering flame, and its smoke blowing away in weird and fantastic shapes, had a fascination which no coke or gas fire could ever have; and if one was going to try to deprive people of the exquisite pleasure of sitting in front of a fire of that sort, one would have to have very strong powers in order to be able to do so.

With regard to the question of costs, it was an exceedingly difficult one, because the range of cost as between different fuels varied both according to the way in which the fuel was used and according to the apparatus in which it was used. There were only two ways in which the relative costs of different kinds of fuels could be measured—the laboratory method and the practical method; and the number of different practical methods varied with the number of different ways in which fuel could be used. The difficulty was that the way in which fuels were used in practical life was not the same as the way in which they were burned in the laboratory. The problem of relative cost was an excessively complicated one.

Sir Alfred Cope, K.C.B. remarked that he was engaged in the anthracite industry. Very little had been said that night with regard to anthracite. Reference had been madé to the glories of New York. New York was not heated by gas coke, nor by low temperature coke, nor by gas or electricity; it was heated by anthracite. His company—the largest producers of anthracite—were exporting to-day to America upwards of half a million tons a year. They were exporting the same amount to Canada. One need not go as far as to New York in order to see the benefits of a smokeless city; one had only to go to Paris, to which this country was exporting one million tons of Welsh anthracite per annum.

He regretted that so much should have been heard of the fact that we had to look forward to to-morrow. Thousands of pounds were being spent in finding out the advantages of gas coke, the kind of apparatus in which it could be burned, how

it could be ignited, and so on, and yet there was at our very doors a natural smokeless fuel in anthracite. Everyone was an advocate of smoke abatement. Nevertheless, the fact seemed to be overlooked that upwards of 80 per cent of this country's production of natural smokeless fuel was exported to countries abroad.

The lecturer had stated that one of the difficulties in obtaining smoke abatement in this country was the inadequate production of gas coke. The lecturer had stated that 7 million tons was the maximum production, and that he looked round for some addition. The anthracite produced in this country was equal in weight to the 7 million tons which the lecturer had referred to, and the thermal efficiency of anthracite as compared with coke, was not in the proportion of 4 to 3, but somewhere in the nieghbourhood of 3 to 2, so that 7 million tons was equal to about 10½ million tons of gas coke. Adding that 10½ millions equivalent of gas coke to the existing supply of gas coke it meant that there was something approaching 20 million tons available. If those interested, by their united efforts, could get 20 million tons of smokeless fuel used in this country, they would be going a long way towards achieving the object in view.

A great deal had been said of the advantages of gas coke for water heating. Certainly it was a very good water heater, but it had many drawbacks, one of which was that the storage capacity of coke was out of all proportion to its heating value. Anthracite took up about half the space of coke, and it did not absorb moisture. Whereas coke contained from 10 to 20 per cent of ash, anthracite did not contain more than 5 per cent.

THE CHAIRMAN said Sir Alfred Cope had stated a good deal about the excellence of anthracite, which nobody denied, but what one would like to know was something about the price. Were its advantages sufficient to outweigh its very much higher cost ?

SIR ALFRED COPE replied that anthracite could certainly never be 50s. per ton, which the lecturer had stated was the price at which it would become competitive with coke ; but if smoke was to be done away with it was not only a question of the first price, but a question of the savings of the housewife in laundry bills, for instance. There was also the question of health and hygiene.

MR. G. NELSON HADEN said it had perhaps been forgotten by previous speakers that in the case of New York a good deal of heating was done from district heating stations. There were in the United States some 400 towns heated to a very large extent from district heating stations. In Detroit there were three main stations, and at one time there were only about five of the large-sized buildings which did not take steam for heating purposes from the central stations. If one went to the outskirts of Detroit and looked over the town, one would see practically no smoke at all from the central station stacks.

MR. W. W. NOBBS (Past-President of the Institution of Heating and Ventilating Engineers) mentioned one point of interest to him as an electrician. As to the use of coke, he only had experience of it in large installations. A short time ago he had attended a lecture at which an electrician had expressed the view that the electric generating companies could sell electricity, at a profit, at .36d. per unit. That gentleman had shown that by maintaining the stations at their maximum capacity, and by turning the excess current generated through a different system to be utilised for heat—heat storage, central heating or hot water heating—the costs would be so lowered that they could sell the surplus heat, at a profit, at .36d.

From what had been said that evening it might be suggested that they might go still further. Why, in such a case, should it not be possible for them to carbonise the smoky fuel, use the gas to heat their boilers, and thus give electricity as a by-product—selling the coke for such purposes as had been mentioned that evening. He thought that was not a too far-fetched solution of the smoke abatement problem, and perhaps more would be heard of it in the future. It seemed to be just as practicable a solution as the use of coke in open grates.

MAJOR P. H. RICHARDSON thought it would be fair to anthracite to point out the difference in the ash and water content of anthracite and coke. He had always held the view that those interested in coke would not secure a very greatly increased use of coke until they took care to reduce the ash content and also the water content —or, rather, the water which coke absorbed. There was 4 or 5 per cent. of ash inherent in anthracite as compared with 15 to 20 per cent. of ash inherent in coke. With regard to the water content, anthracite had about 4 per cent. of water and would not absorb more. Coke had 7 or 8 per cent. of water and would and could absorb up to 20 per cent. When it was realised that both water and that ash had to be heated up to the temperature of the fire and then the ash had to be removed, it would be found that the B.Th.U. which one got from coke for a penny and the B.Th.U. that one got from the anthracite were nearly equal, without taking into account the cost of labour for removing the ash. He did feel that if the 7 million tons of potential output of anthracite could be used, added to the output of the coke which there was in the country, plus the output of coke from the coke oven people, we need not look very far ahead for the day when it could be said to Parliament that there was an alternative fuel ready and that a law should be passed that in three years' time smoke must not be put out into the air. He would stress the point that if Medical Officers of Health were more strict in using the influence which they had, the stage at which everyone wanted to arrive would be reached much quicker than many people thought.

MR. E. J. B. CLARKE said, as a stove man, that the very fact that a fire had to be lit by gas revealed the weakness of the case for coke. He pointed out that there were about 1,200 deaths last year through gas, and he thought the method which the lecturer had put forward that night was only increasing those risks. He agreed with the Chairman that low temperature carbonisation would provide one of the fuels of the future.

MR. ARNOLD MARSH (Secretary of the Smoke Abatement League of Great Britain) said he was sorry no distinction had been made in the types of coke with which the lecturer had been dealing. There was coke and coke. The older types of coke contained anything up to 20 per cent. of moisture and were unsuitable for the open grate, but the modern vertical cokes would burn excellently in an ordinary open grate. In Manchester they had had special opportunities of studying the smoke question. Taking Manchester alone, out of a population of three-quarters of a million, there were a half a million people living in houses generally known as "two up and two down." That meant that in those houses it would take years to fit in new types of grates. The problem had to be solved by giving such people a fuel which would be cheaper than coal and which would burn in the existing type of grate. The modern vertical coke would do that, and when low temperature fuel was got down to a reasonable price, as he thought it would be in the near future, then a fuel would be able to be given to those people in those small houses

in large congested areas, without the necessity of undertaking the almost impossible job of changing their grates and fittings.

PROFESSOR DARLING, in reply, said he had been sorry to observe that in the discussion the question of the capacity of the poorer people to pay for the necessary contrivances had not been taken into account. That lay at the root of the whole problem. One of the main reasons why he had advocated the burning of coke was because it was cheaper than anything else, at the same time being smokeless. Low temperature carbonisation coke had been coming as long as he could remember, but it had not yet come, and he did not think we could afford to wait until that millennium before getting a move on. There were three million tons of coke available in London for domestic use, and his suggestion was that we should get on using that, and then the movement would grow by its own force. It was all very well to say what was done in New York, but the average income of an inhabitant of New York was very much higher than in London. Most people here could not afford anthracite. He was a strong advocate of anthracite if it could be brought within the means of the classes who were now producing most of the smoke. If only the varied interests, who only seemed concerned to push their own gadgets as against all others, would come together and combine and have a common interest--namely, the removal of the smoke nuisance—then the problem would soon be solved, but so long as they were all at loggerheads, all advertising against each other, and pointing out the weaknesses of each other's methods instead of drawing attention to each other's good points, there must be a deadlock. Coke fires were growing simply by their own recommendation, but that was too slow a process. Legislation could not be enforced until an alternative fuel was available at a cost which the people could afford, but given those conditions he quite agreed that there should be legislation. In the meantime an immense amount could be done without legislation by all the interests combining and pulling together. By such means he thought the problem would largely solve itself.

LIEUT.-COLONEL SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., then proposed a hearty vote of thanks to the lecturer for his brilliant lecture. Personally, he regretted that not more ladies had been present that evening, because, after all, the question of what type of fire was to be established in a house, lay less in a mere man's hands than in those of his wife. He had been brought up in Rochdale—the dirtiest town in Lancashire. Any discussion of the sort which had taken place that night was of very real value. From his office in Finsbury Circus he could see something like 800 chimneys, not more than 80 of which he was certain were in any way necessary. If the number of chimneys could be generally reduced on that scale, there was no doubt that a great deal of good to the health of the community would result. Nevertheless, it was to be remembered that the health of London was on the average better than the health of the average rural district, so that Londoners had much to be thankful for.

He desired to invite those present to become members of the Society. They wanted good lectures, and the Society could give them. This session already an almost unique lecture on fuel had been given by a former Director-General of Naval Construction, which had been followed by a most valuable discussion. There were about to be given a series of three lectures by the Director of the Fuel Research Station at Greenwich—which was to fuel research all over the world what the longitude of Greenwich was to navigation all over the world. Lectures of equal value, which could not be surpassed in any other Institution in London, were given

at the Royal Society of Arts on most Mondays and on every Wednesday and often on Fridays, covering an extraordinary variety of subjects. The Royal Society of Arts was, he believed, the only learned Society which published a weekly journal, so that its members got week by week a complete paper, which they would refer to for years to come. The Society was not a fellowship of learning alone; it was a fellowship to encourage the arts, manufactures and commerce. Membership did not suggest that the fellows themselves were learned, but it meant that they were trying to learn, and to encourage others to learn. He extended a hearty invitation to all those present, and to others, to become members of the Royal Society of Arts.

The vote of thanks having been carried unanimously, the meeting terminated.

MR. E. W. L. NICOL (London Coke Committee) writes:- As time did not permit of an adequate reply to those speakers who, admitting their personal interest in anthracite coal, represented gas coke to be a relatively inferior fuel, I now beg to offer the following contribution to the discussion on Professor Darling's interesting lecture on domestic coal smoke prevention. It was suggested by Sir Alfred Cope and Major Richardson that the moisture and ash content of gas coke was as high as 15 per cent. and 25 per cent. respectively. It would be as inaccurate and as futile to say the same of the finest solid fuel the world can offer, namely, Welsh and Scottish anthracitic coal. Coke is sold in competition with anthracitic and other high-priced coals, largely for domestic purposes, and finds favour entirely upon its merits as the more efficient and economical fuel. As Professor Barker pointed out, there is no generally applicable method of comparing the relative efficiency of fuels for all purposes, but the one unassailable method of comparison for commercial as well as domestic purposes is the net evaporative test adopted universally by mechanical and civil engineers. Such tests, which take into account the efficiency of both apparatus and fuel, are made continuously by important public authorities who are large consumers of gas coke for steam raising and central heating. These include the London County Council and the Metropolitan Asylums Board, whose published test results of coke-fired boilers prove an average overall thermal efficiency of 80-86 per cent., and a net evaporation of 10 lb. of water per 1 lb. of coke, while the Metropolitan Water Board, whose fuel testing laboratory is probably the best equipped establishment of its kind, purchase gas coke upon a guaranteed calorific value basis of 12,000 B.Th.U. per 1 lb., which necessitates the maintenance of a minimum ash and moisture content. There is therefore no possibility of selling to such large and discriminating buyers, or to any one of ordinary intelligence, coke of the description which exists only in the imagination of the speakers whose hyperbolic advocacy of anthracite coal at the expense of a successful competitor is indicative of the futility of intensive, but non-technical, fuel salesmanship—a common failing which, in my opinion, is largely responsible for the unfortunate position of the British Coal Industry at the present time. A calorific power of 15,200 B.Th.U. per lb. is often claimed for anthracite coal containing 2-3 per cent. ash; but this claim is difficult to reconcile with the fact that pure amorphous carbon (ash and moisture free) has a calorific power of only 14,560 B.Th.U. per lb. Perhaps our anthracitic friends will explain this apparent discrepancy, and its effect upon the apparent B.Th.U. per 1d. of cost, according to Professor Darling's tabulated figures.

As Engineer and Fuel Expert to the London Coke Committee it has been my privilege during the past 15 years to conduct personally many evaporative tests at electric and other power stations, in order to prove the relative efficiency and adaptability of gas coke to existing boilers and apparatus, with the selfish object of substituting coke for coal; and, on a cost and efficiency basis, which, usually, are the only criteria, there has seldom been any serious difficulty in competing successfully with raw coal of the most expensive descriptions. Similarly, coke has been adapted, by means of careful grading, for use in domestic stoves designed primarily for anthracite; and graded coke is now generally regarded as interchangeable with the latter fuel. But, of course, such competition is not in the true spirit of Professor Darling's lecture. His obviously unselfish object is to obtain for the benefit of the community the combined effect of anthracitic coal, electricity, gas and coke in combating the bituminous coal smoke evil.

With our vast supplies of indigenous smokeless coals (now largely exported) and manufactured smokeless fuels, gas and coke, and scientific stoking, much could be done by good salesmanship to break down the ignorant prejudice against smokeless methods of heating which, alas, is still all too common, even in high places. The important position of the gas industry in this regard is indicated by the service provided for the convenience of the Metropolitan community. At London and Suburban gas works in a normal year some 5.5 million tons of coal are carbonised, producing over 65,000 million cubic feet of gas and, in addition to the other valuable by-products 2,600,000 tons of gas coke for sale, of which about 400,000 tons are exported. The fact that the remaining 2,200,000 tons of coke are consumed annually in and around London, largely and increasingly for domestic purposes, should add materially to the dismay and confusion of coke's detractors, as it is irrefutable evidence that gas coke holds, on its merits, a very strong position in the favour of the London public. One speaker has pointed out that gas coke made in vertical retorts is more re-active and suitable for use as fuel in most modern fire-grates. The denser horizontal coke, like most solid fuels, gives the best results in grates specially designed for its use. These are divided into two essentially different classes, namely, the insulated (or built in) flaming type, in which the coke burns of its own volition at a relatively high temperature, the chimney draught having but little influence upon the rate of combustion. Of this type the "Metro" is undoubtedly the most effective and popular. The other type is represented by the positive or down-draught non-insulated (self set) grate which embodies means of control to which the Chairman and the Fuel Research Board have attached so much importance, and which certainly tends towards rationalisation, convenience, and economy in the use of fuel. Of the latter type, several models have been tested, but only those in which there is no metal in contact with the burning fuel, and which are provided with some form of shaking bottom, promise to survive the gruelling effects of coke in active combustion. After an expensive process of development and elimination, an open gas-ignited fire of this description will shortly be offered to the public at a relatively low price. Unlike gas and electric apparatus, which can use no other fuel, coke appliances are equally suitable for competing fuels; and it is in this direction, namely, in the co-operative design, development and sale of smokeless solid fuel apparatus that Professor Darling's high ideal of combination of forces in combating the common evil is, in my opinion, most likely to be realised.

OBITUARY.

CEDRIC CHIVERS, J.P.—We regret to announce that Alderman Cedric Chivers, who was in his sixth year of office as Mayor, died at Bath, on January 30th, at the age of 75. Mr. Chivers, who was a self-made man, established an international reputation as a book-binder. He invented a new method of stitching which added greatly to the life of library books as well as a new process for decorating choice volumes. He was well known in the U.S.A., where he had a factory in Brooklyn, New York, and in fact started operations there in response to a round robin addressed to him by American librarians. It was said of him that he had crossed the Atlantic 120 times, and that he had been in more libraries in the United States than anyone living.

Alderman Chivers established a reputation for dispensing a liberal hospitality to conferences meeting at or visiting Bath, and was a generous supporter of charitable causes. He had been a Fellow of the Society since 1901, and read a valuable paper on " Book-binding," at one of its meetings in 1925

EXHIBITION OF APPLIED ART

EXHIBITION OF POTTERY Miss Down, 95, Belgrave Road, S.W.—It has probably often struck most people that vases which are beautiful in themselves do not necessarily make good receptacles for flowers. On the contrary, flowers spoil such vases. That it is possible to make vases deliberately to suit flowers, without sacrificing design, is proved by Miss Down's work. Symmetry she does sacrifice ; perhaps at present she is more dogmatic about the demerits of regularity than she will be later on, but anyhow, balance is just as valid a basis for design as symmetry, and the balance of Miss Down's vases is sometimes most attractive.

Miss Down is a pupil of Professor Ledward, and her personal bias is against the employment of the potter's wheel. She builds up her vases with pellets of clay—a little too often making her general effect suggestive of fir-cones—and afterwards bakes them : not in the sunshine on the banks of the Nile, as she logically should, with her views on mechanical aids to art, but in a small kiln.

Miss Down has produced both some fine monochrome glazes and some rather more matt painted surfaces. A really beautiful Chinese green is perhaps the best representative of the first group, and a pink gingham of the second.

Her present exhibition is humble only in its proportions ; we look forward to seeing more of her work soon, in a locality more accessible (for her sake, not ours) to the public which is interested in this pleasant aspect of ceramics.

NOTES ON BOOKS.

THE SPECTROSCOPY OF THE EXTREME ULTRA-VIOLET. By Theodore Lyman. London : Longmans, Green & Co. Pp 160+VI. 10*s.* 6*d.* nett.

We have been familiar for many years with the fact that X rays, ultra violet rays and ordinary light are radiations which owe their characteristic differences to their differences in wave-length. It has, however, required considerable time and experimental skill on the part of a large number of observers to produce and measure the whole range of radiations from the wireless waves at one end of the spectrum to the cosmic rays at the other.

Considering the radiations of wave-length less than those of visible light, we find that Ritter in 1801 discovered chemically-active rays beyond the violet, which

Young showed were of a shorter wave-length than those observed by the eye. About 1840 the solar spectrum was photographed using glass prisms and gratings, while wave-length 3,400 A.U. was reached. The next considerable advance was due to Stokes about 1862, by the use of a quartz prism, an electric spark and a fluorescent screen. He appears to have observed the strong line in the aluminium spark at wave-length 1850 A.U. This remained the limit until comparatively recent times. It will be noticed that each further penetration into the ultra-violet was accomplished as a result of the application of a change either in the dispersion system, in the light source or in the method of recording. Subsequent developments have since been accomplished by the same methods, each change resulting in a substantial advance into unexplored territory.

It was Schumann, however, who gave the impetus to modern investigations in this region. This remarkable worker commenced his scientific work when over forty years of age as a relaxation from his regular profession, and it is in honour of his brilliant pioneer work that his followers have named the portion of the spectrum below 2,000 A.U. the Schumann region. At the time of his death in 1903, after about fifteen years work, he had managed to observe the spectrum down to about wave-length 1,200 A.U. To do this he had to substitute fluorite for quartz, since quartz begins to absorb at about 1,850 A.U., prepare special plates without gelatine, since gelatine begins to absorb at about 2,400 A.U., and also to place his apparatus in a vacuum, since air begins to absorb near 1,850 A.U. With these modifications he obtained the spectrum of hydrogen down to about 1,200 A.U. Schumann, however, was not able to measure wave-lengths in this region, owing to the absence of data on the dispersion of fluorite.

It was at this stage that Lyman commenced his researches. He improved on Schumann's apparatus as a result of development in vacuum technique, and by substituting a concave grating for the fluorite prism and lenses was able to make the first measurements of wave-length in the Schumann region and so attach a wave-length scale to Schumann's results. By 1914, when the first edition of his well-known book was published, he had made measurements down to about 900 A.U., by 1915 to about 600 A.U., and by 1917 to about 500 A.U.

The next and final advance was made by Millikan in 1919 by the use of a new source—the vacuum hot spark, which is particularly rich in short wave-length radiation. The present limit of the optical spectrum as set by Millikan in 1924 is the line 136 A.U., which is thought to be due to oxygen, or possibly to be one of the L series of the X rays from aluminium. Thus by optical methods the region of X rays has been reached.

Contemporaneously with the work of Lyman and Millikan, observers working from the X ray end of the spectrum have been measuring softer and softer X rays, until in 1926, Dauvillier, using as a grating a crystal of the lead salt of mellissic acid, which has the extremely large lattice spacing of 87.5 A.U., measured X rays of wave-length 121 A.U. from thorium.

Finally the gap was bridged by Osgood in 1927, who used a concave glass grating with X rays at grazing incidence. He obtained on the same plate lines corresponding to wave-lengths from 45 A.U. to 211 A.U., thus joining and overlapping the limits set by Dauvillier and Millikan.

In the second edition of his book, which has just appeared, Professor Lyman gives an account of the experimental technique for which he has largely been responsible in connection with photography and measurement in the ultra-violet portion of the spectrum.

Professor Lyman also gives a summary of the researches which have been undertaken to explain the sharp limit in the solar spectrum which is observed near wave-

length 2,900 A.U. This has long been attributed to absorption in the earth's atmosphere, but as the limit is practically the same at sea level and at 12,000 feet, it was difficult to account for satisfactorily. Recent investigation indicates that the limit is due to the absorption of zone at an altitude of 45 to 50 kilometres.

The major portion of the book, however, consists of data on the absorption and reflection characteristics of a number of elements and compounds, and also wavelength data on emission spectra.

Professor Lyman has written a very useful book on a very interesting subject, and although the treatment is scarcely suitable for the general scientific reader, it should, however, prove of great value to the research worker in this most important region, both as a manual of method and as a reference book of data.

Very few misprints have been noted. The author appears to be mistaken in the origin of some of his gratings. They were made on the Blythswood ruling engine at the National Physical Laboratory. We are unacquainted with the Blaesthwood machine or the National Research Laboratories in England.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 18.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Mr. J. Alfred Gotch, "Modern Banks, with special reference to the new Midland Bank Head Office."

Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

British Empire Producers' Organization, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 4.30 p.m. Sir Benjamin Morgan, "Intra-Empire Economic Co-operation."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Modern High Power Rectifiers: their Development and Use," opened by Mr. R. L. Morrison.

At the University, Liverpool. 7.30 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Mr. Edward Corcoran, "Experiences as a Farm Hand in Canada."

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. G. Binney, "Hudson Bay in 1928."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. George Bird, "Railway Brakes."

University of London, at University College, Gower Street, W.C. 2 p.m. Miss M. St. Clare Byrne, "Elizabethan England."

5 p.m. Dr. W. H. Craib, "Electrical Phenomena in Muscle and Nerve." (Lecture III.)

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture II.)

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture VI.)

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Lt.-Col. T. C. Skinner, "The Ice Age: its Astronomical Cause and the Bearing of Drayson's Discovery on the Biblical Account of the Deluge."

TUESDAY, FEBRUARY 19.. Automobile Engineers, Institution of, at the Engineering Scientific Club, Wolverhampton. 7.30 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. A. H. Barker, "The Electrical Heating and Ventilation of Bourne and Hollingworth's Premises, Oxford Street."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. W. Cruickshank, "Voice-Frequency Telegraphs."

Heating and Ventilating Engineers, Institution of, at Milton Hall, Manchester. 7 p.m. Mr. G. E. Shuttleworth, "Dust Removal."

Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, S.W. 6.45 p.m. Discussion on various Problems in Illuminating Engineering.

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. E. C. Evans, "Fuel."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture IV.)

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Dr. A. Bradford Hill, "The Investigation of Sickness in various Industrial Occupations."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. Frank Pick, "The Administration of Transport Undertakings."

At the Queen's Hotel, Birmingham. 6 p.m. Mr. A. A. Jackson, "The Sphere of the Railless Trolley Vehicle."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question: (Lecture VI)—The Crimean War and the Treaty of Paris."

5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Traction." (Lecture II.)

At the Royal School of Mines, South Kensington, S.W. Mr. F. L. Engledow, "Plant Breeding." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. (Lecture IV) on "The Current Work of the Biometric and Eugenics Laboratories."

8.15 p.m. Miss E. Jeffries Davis, "Historical Factors of the Problem of London Traffic." (Lecture III.)

Zoological Society, Regent's Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, FEBRUARY 20.. British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Mr. Stanley Casson, "Excavations in the Hippodrome at Constantinople (Second Season)."

Central Asian Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Dr. Anderson, "The Highway of Eurasia."

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Mr. H. I. Beel, "Egypt under the Caliphs of Damascus."

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Address by Lt.-Col. K. Edgcumbe.

Geological Society, Burlington House, W. 5.30 p.m. Dr. C. A. Matley and Mr. F. Higham, "The Basal

Complex of Jamaica with special reference to the Kingston District."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. Mr. L. H. G. Dines, "The Baker automatic release for dropping the meteorograph from a registering balloon at a predetermined height." (2) Mr. C. K. M. Douglas, "Some Aspects of Surfaces of Discontinuity." (3) Dr. E. Kidson and Mr. H. M. Treloar, "The Rate of Ascent of Pilot Balloons at Melbourne."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. (1) Dr. R. G. Canti and Mr. F. G. Spear, "Some Effects of Radium on Cell Division *in vitro*." (2) Mr. S. F. Cox, "Some Effects of X-Rays on Cell Division *in vitro*." (3) Mr. F. G. Spear, "An Effect of Low Temperature on Cell Division *in vitro*." Demonstrations by (1) Mr. S. F. Cox on "The Effect of a Heavy Dose of X-Rays on Living Cells as shown by the Dark-Ground Method." (2) Dr. R. G. Canti on the "Cell Division in the Living Tissues cultivated *in vitro*."

United Service Institution, Whitehall, S.W. 3 p.m. Group Captain P. F. M. Fellowes, "The Present Position of Airships."

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne. 7.15 p.m. Mr. W. G. Thompson, "Some Unusual Aspects of Combustion in Engines and Boilers."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture I.)

At King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History: (Lecture VI)—Mr. H. M. Hake, "English Portraits."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928: (Lecture VI)—Novels of the Revolution: Pilnyak to Fedin."

At the London School of Economics, Houghton Street, Aldwych, W.C. 6 p.m. Mr. F. Hutchinson, "Measuring Output in Office Practice, II."

At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture V.)

5 p.m. Dr. A. S. Parkes, "The Physiology of Reproduction." (Lecture VI.)

5.30 p.m. Mr. I. C. Grondahl, "Wergeland and the Norwegian Lyric." (Lecture III.)

5.30 p.m. Mr. J. Haantjes, "A Dutch Play of Mary Queen of Scots."

THURSDAY, FEBRUARY 21.. Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Carpenters, Worshipful Company of, Carpenters' Hall, Throgmorton Avenue, E.C. 8 p.m. Mr. Raymond Unwin, "The Housing Problem and how it has been met."

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part II: The Dependence of Quantum Efficiency on Wave Length." (2) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part III: A Comparison of the Thermal, Photochemical and Electrical Decompositions, and a General Theory of the Change." (3) Mr. R. G. W. Norrish, "Photochemical Equilibrium in Nitrogen Peroxide. Part IV: Fluorescence and Photochemical Activity." (4) Messrs. A. T. Dann and W. Davies, "The Reactions of Nitrosulphonylchlorides. Part I: The Reaction of Hydrazine Hydrate with o- Nitrosulphonylchlorides."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Dr. K. Ott, "The Erection of the Mechanical and Electrical Part of the Shannon Scheme."

L.C.C. The Horniman Museum, Kingsland Road, E. 7.30 p.m. Mr. L. A. Turner, "English Decorative Plasterwork."

Mechanical Engineers, Institution of, at Queen's Hotel, Birmingham, 6.30 p.m. Mr. W. B. Challen, Chairman's Address.

Mining and Metallurgy, Institution of, Burlington House, W. 5.30 p.m. Mr. W. Cullen, "The Possibilities of Reviving Non-Ferrous Metallurgy in Great Britain." (Resumed Discussion). Mr. C. R. Julian, "Some Notes on a Tunnel driven at Rio Tinto, Spain."

Oil and Colour Chemists' Association, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. T. Wilson, "The Fresco Ordeal: its Chemical and Artistic Implications."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. A. O. Rankine, "Physics in Relation to Oil Finding."

University of London, at the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Mr. Harold J. Laski, "Thomas Hobbes."

At King's College, Strand, W.C. 5.30 p.m. Mr A. E. Twentyman, "German Education since the War: (Lecture II)—The Elementary School."

5.30 p.m. Dr. Edgar Prestage, "D. Francisco Manuel de Mello, a Portuguese and Spanish Classic."

5.30 p.m. "Czechoslovakia." (Lecture VI.) Dr R. W. Seton-Watson, "The Slovaks—Then and Now."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture V.)

At University College, Gower Street. 5 p.m. Dr R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture V.)

5 p.m. Mr. H. R. Ing, "The Chemistry of some Natural Drugs." (Lecture VI.)

5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: a Course for Laymen." (Lecture I.)

5.30 p.m. Prof. Dr. Edmund G. Gardner, "The Italian Story of Merlin."

Victoria and Albert Museum, South Kensington, S.W 5.30 p.m. Mr. James Laver, "Some Designers for Ballet."

FRIDAY, FEBRUARY 22.. Engineering Inspection, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.30 p.m. Mr. A. S. Grunspan, "Specification Notes and Good Practice relating to Concrete and Reinforced Concrete Work."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. J. Calderwood, "The Application of the Heavy Oil Engine to Yachts and Small Craft."

Mechanical Enginners, Institution of, at the Engineers' Club, Manchester, 6.30 p.m. Captain D. Richardson, "Welding Processes."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. George Baker, "Electrical Precipitation."

At the Engineers' Club, Manchester. 7.15 p.m.

North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne. 6 p.m. Dr. G. W. Todd "The Relation between the Properties of Engineering Materials and their Ultimate Structures."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) L. F. Stanley, "The Construction and Calibration of a Sensitive form of Pirani Gauge for the Measurement of High Vacua." (2) Dr. Charles H. Lees, "The Free Periods of a Composite Elastic Column or Composite Stretched Wire." (3) Dr. Allan Ferguson and Mr. J. A. Hakes, "A Capillary Tube Method for the Simultaneous Determination of Surface Tension and of Density." (4) Dr. E. H. Rayner, "A Demonstration of a Standard Electrostatic Voltmeter and Wattmeter, used for Measurements of alternating Currents at power frequencies at the National Physical Laboratory."

Royal Institution, 21, Albemarle Street, W. 9 p.m. "Lily-Stars of the Sea: How they fit their Surroundings."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture II.)

At King's College, Strand, W.C. 5.30 p.m. Mr. Vernon Rendall, "Shakespeare and Scott."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture I.)

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture VI.)

5.30 p.m. Dr. J. Howard Jones, "Hygiene of the Mercantile Marine." (Lecture I.)

SATURDAY, FEBRUARY 23.. L.C.C. The Geffrye Museum, Forest Hill, S.E. 3.30 p.m. Dr. Bernard Smith, "Zermatt and its Glaciers."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Dr. E. Bullock, "Music in Cathedral and Collegiate Churches." (Lecture III.)

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FRIDAY, FEBRUARY 22nd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK

MONDAY, FEBRUARY 25th, at 8 p.m (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., Senior Medical Inspector of Factories, 1898-1927, " Thirty Years' Experience of Industrial Maladies." (Lecture II.)

TUESDAY, FEBRUARY 26th, at 4.30 p.m. (Dominions and Colonies Section.) DR. H. J. VAN DER BYL, Chairman, South African Iron and Steel Industrial Corporation, Ltd., " The South African Iron and Steel Industry." SIR WILLIAM J. LARKE, K.B.E., Director, National Federation of Iron and Steel Manufacturers, will preside.

Tea will be served in the library before the meeting from 4 o'clock.

WEDNESDAY, FEBRUARY 27th, at 3 p.m. General Meeting in connexion with the Fund for the Preservation of Ancient Cottages. THE RIGHT HON. J. RAMSAY MACDONALD, M.P., will preside, and the speakers will include MR. G. K. CHESTERTON, LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., SIR GEORGE SUTTON, Bt., Chairman of the Council, and others.

Admission will be by ticket only, and Fellows wishing to be present are requested to communicate at once with the Secretary.

WEDNESDAY, FEBRUARY 27th, at 8 p.m. (Ordinary Meeting.) A. F. SUTER, " East Indian Copals and Damars." J. G. WATSON, Forest Economist of the Forestry Department, Federated Malay States, will preside.

COUNCIL.

A meeting of the Council was held on Monday, February 11th. Present:— Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E.; Sir Atul C. Chatterjee, C.I.E.; Sir Edward Gait, K.C.S.I., C.I.E.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Mr. John S. Highfield, M.Inst.C.E.,

M.I.E.E.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S.; Sir Richard Redmayne, K.C.B.; Mr. Alan A. Campbell Swinton, F.R.S., and Mr. Carmichael Thomas, with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society:—

Angus, Roy Alexander, Toronto, Canada.
Barrow, George Curzon Romaine, London.
Bason, Albert, Macclesfield
Cairns, Harry Lister, Winnipeg, Canada.
Chanler, Albert, London.
Cumberbatch, Elkin Percy, M.A., M.B., M.R.C.P., London.
Dash, William Gerald, Weston-super-Mare.
Denson, William Henry, J.P., Chester.
Farnsworth, Frederick D., Fort Fairfield, Maine, U.S.A.
Fisher, Mrs. W. Rowland, Bourne End, Bucks.
Forbes, Mansfield D., M.A., Cambridge.
Hussain, Sh. Manzur, Loughborough, Leicestershire.
Huttinger, William Reynolds, Lansdowne, Pa., U.S.A.
Lahiri, S. K., Calcutta, India.
Londt, William Edward, Port Elizabeth, South Africa
McDonald, Edward T., Chelmsford, Essex.
Pearson, Mrs. L. K., London.
Railing, Adolph Harry, D.Sc., Sutton Coldfield.
Richardson, Captain Leslie, Menton, France.
Sachs, Leo Ferdinand, London.
Schelling, Mrs. Henry, New York City, U.S.A.
Seeler, Edgar Viguers, Philadelphia, Pa., U.S.A
Yeaman, John Alexander, W.S., Edinburgh.
Yorke, Algernon J., Kingstonbridge, Sussex.
Ziegler, Carl A., Philadelphia, Pa., U.S.A.

It was reported that H.R.H. the President had nominated the Hon. Sir Charles Parsons, O.M., K.C.B., F.R.S., a Vice-President of the Society.

Lord Bledisloe, K.B.E., was elected a Vice-President of the Society.

Further consideration was given to the question of the award of the Society's Albert Medal for 1929.

Arrangements for the first Annual General Meeting of subscribers to the Fund for the Preservation of Ancient Cottages on February 27th were considered and approved.

Copies of the prospectus of the Sixth Annual Competition of Industrial Designs were laid on the table, from which it appeared that over £2,000 would be offered in scholarships and prizes this year.

A report of the British Science Guild on the Reform of the British Patent System was considered and generally approved.

In view of the greatly increased number of entries for the Society's Examinations, it was resolved to reconstitute the Examinations Committee

and to secure on it the representation of the principal bodies interested in Commercial Education.

Mr. A. Kahn, Chief Examiner, was appointed to represent the Society at the International Congress of Commercial Education to be held in Amsterdam in September next.

The arrangements for the latter part of the session were considered.

A quantity of financial and formal business was transacted.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 13th, 1929. MR. H V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, in the Chair.

A paper on "Fruit Pollination in relation to Commercial Fruit Growing" was read by MR. CECIL H. HOOPER, F.L.S., of the South-Eastern Agricultural College, Wye.

The paper and discussion will be published in the *Journal* on April 5th.

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

WEDNESDAY, JANUARY 23RD, 1929.

THE RT. HON. THE EARL OF CRAWFORD AND BALCARRES, K.T., P.C., LL.D. F.R.S., P.S.A., in the Chair

THE CHAIRMAN, in introducing the lecturer, said the subject was that of Museums and Education one with which Sir Henry Miers of all people was best qualified to deal. Many years ago Sir Henry Miers had been connected with the Natural History Museum. Subsequently he had acquired a very well-recognised place in the world of science. Then, as head of a great modern university in the North of England he had rightly come to be looked upon as protagonist of higher scientific education. Since then it had fallen to his lot to inspect and to report upon every single museum in the British Isles. That was a feat of courage and endurance which few would dare to try and emulate. Sir Henry had accomplished it, however, and therefore could anybody be better qualified than Sir Henry to deliver a lecture upon Museums and Education?

The following paper was then read:—

MUSEUMS AND EDUCATION.

By SIR HENRY A. MIERS, M.A., D.Sc., F.R.S., F.G.S., F.C.S.

If the walls and roofs of all the museums of the country were to become transparent a spectator gifted with a miraculous power of vision and able at

one moment to see all that they contain, would perceive an extraordinary display of miscellaneous things: natural history collections, works of art, pictures, furniture, antiquities: exhibited in cases or stored in drawers. In some places they would appear to be beautifully selected and displayed, in others they would be a mixture of incongruous objects. But, taking the museums together, he would see that they contain, together with much rubbish, a vast mass of valuable material, an enormous assemblage of rare, interesting and beautiful things from all parts of the world, and relating to all the ages.

Looking at the country as a whole, he would see two parts of the British Isles in which this material is closely concentrated, namely, the London district, and Lancashire with the West Riding of Yorkshire. In other parts of the country he would see large areas in which there is none.

Turning first to the more important and prosperous museums, especially in the larger towns, he would see visitors wandering about in a somewhat aimless fashion. At certain times of the day there would be crowds; at other times, unless it was a wet day, they might be almost deserted. The National Museums in London, Edinburgh, Cardiff, and Dublin, would contain many visitors during almost the whole day. In these, and in only three or four of the others, guide lecturers would be conducting parties of serious visitors and explaining exhibits to an attentive audience, but even here some of the galleries would be deserted.

In a fair number of museums a class of school-children might be hearing a lecture from their teacher, or from the Curator, and busily making notes and sketches of exhibits. In a few, students from art schools would be making copies

Here and there would be seen persons engrossed in the examination of some particular object. In a few of the more lively institutions there might be quite a crowd round some new or exciting exhibit, because it had been described in the local press. The Curators would probably be occupied in dealing with enquiries; only in the National Museums, and in half a dozen of the local museums, would members of the staff be seen in their work-rooms engaged in research.

Turning his attention to the less important and less prosperous museums, our observer would find such signs of activity comparatively rare; in many of them and during a considerable portion of the day, the rooms would be deserted A general air of stagnation would be apparent; visitors would come and go without much evidence of interest. They would receive little or no help towards understanding the exhibits; they would be gazing at rows of things of no interest to them, over-crowded and sometimes very badly lit; there would be no one to apply to for information.

One museum would be empty save for a family of children with their nurse wandering among cases full of fossils and flint implements, until their mother, who had brought them in from the suburbs and deposited them there, should return from her shopping.

In another a group of tawdry girls would be using the glass of the mummy case as a mirror in order to beautify their complexions.

A third would be deserted, the caretaker would be asleep, and the side rooms would be locked lest stray children should get into them unobserved.

Turning his eyes to the worst and most neglected museums of all, he would see dark and dilapidated rooms with old cases full of decaying curiosities, among which he would descry a certain number of rare and valuable objects perishing irretrievably. One would have its cabinets and drawers locked with keys that cannot be found; another would have a dismal room closed to visitors because its floor is unsafe; in a third the table cases have been stacked in a corner to make room for a whist drive Needless to say, such museums have few, if any, visitors.

Prying thus into the contents of the museums of the British Isles in a general survey our keen-sighted observer would probably be led to ask himself why so much of their valuable material is not being used. He might ask why, in most instances, the exhibited objects are so hopelessly crowded together, and why the majority of visitors drift from room to room without more than a passing interest.

If he were able at the same time to see the contents of the libraries of the country, he would observe a marked contrast. In most of them, and during a great part of the day, there would be numbers of persons in the reading and reference rooms, and many readers in the general library (especially if it possessed the open access system) selecting books to take home with them; on some afternoons in many libraries he would see eager crowds of children searching the books in the children's room. Everyone would be there with a purpose. He would also see, in many parts of the country, motor vans delivering books to schools and other centres in the rural districts

In other words, he would recognise at once that there is an organised library service throughout the country, that a large proportion of the books are in constant use, and that all of them are stored for the purpose of being used as soon as required. He would be struck by the great difference between them and museums where there cannot yet be said to be anything like a national service, and where the visitors are for the most part strangers to the district or town, and are mere sightseers, half of whom make little or no personal use of the treasures that they contain.

Please understand that the picture which I have drawn is no fanciful one; everything that I have mentioned, or that I shall mention later, has been seen by myself within the last two years; anyone who has had a similar experience can easily understand why, in so many quarters, museums have a bad name; why the very word museum suggests to many people stuffy, overcrowded and uninteresting rooms that breed weariness and headache; and why they are so little known to the public.

It has been my habit in visiting towns to ask persons in the streets the way to the museum, with the object of discovering what proportion of them know anything about it. In one town I spent more than an hour in the evening in this pursuit before I discovered anyone who knew of its existence, and he was a boy who, after saying that he had never heard of one, ran back to add that he believed there was a case of birds on the staircase in the library. There was, in reality, quite a considerable natural history collection filling a large room in the library building.

In another town many people, including the policeman on point duty at the main cross-roads, assured me that none existed, and he was surprised when I returned in half an hour to tell him that I had visited it. Adequate street notices directing the visitor to the museum are rare in most places.

In a third large town I went to the address given me by the Town Clerk, described as an Institute with a considerable museum, only to find that the latter had ceased to exist five years ago.

In such places, and in many others, the museum clearly plays no real part in the life of the people; it is not regarded as one of the assets of the town.

Those who suffered in childhood from enforced visits to one of the old fashioned and more dismal may be forgiven for a lifelong dislike to all museums. If, however, they will correct their impression by a visit to a really good museum of the present day they will see how attractive and useful they can be made if administered by a good Curator and an enlightened Committee of Management.

The sight of eager children crowding round the exhibits in the Science Museum, or listening to a talk in the London Museum, or entering gleefully one of the more attractive provincial museums, will prove to such critics that, at any rate in some places, a new generation is growing up to whom the name has a very different meaning; and one of the most encouraging features of the situation is that the children of this new generation are taking their own parents to enjoy what they have been accustomed to shun.

There are bright spots even among the poorest museums—collections of local antiquities or of natural history specimens made and arranged by experts and enthusiasts, or storehouses of material well exhibited for the instruction of children and other visitors, who do make good use of them.

Why, then, with such great possibilities before them, do the museums of the country on the whole excite so little interest?

Why can they not all be brightened up and made useful? What is the disease from which so many suffer, and what is the remedy?

To answer this question one must look a little more closely into the nature of their contents and so learn something about the manner in which they have originated and the process by which they have grown.

In the first place, anyone who visits a good many of them, as I have done, will be struck by the similarity of their contents, and at the same time by their very mixed character.

In not a few of the older and more stagnant museums are still to be found the old outrageous types of "curios": such things as the two-headed calf, stones shaped like animals, or with queer markings like profiles, bottles containing unnamed reptiles, an albino bird, a boomerang labelled "savage weapon," a purse made out of a murderer's skin, the impressions of a coin in lava, a petrified bird's nest.

More recently, war relics have given an excuse for preserving fragments of aeroplanes and shells, battered helmets, and other odds and ends.

But, putting these aside and looking only at the more usual things, it will be seen that most museums, though they have the whole world to choose from, are exhibiting the same sort of objects and seem only to be trying to excel each other in the magnitude of their collections. Some curators, like some collectors, have become slaves to the lust of acquisition and the pride of possession. In my opinion the immediate problem for most museums is not so much how to get more material as how to make the best use of what they have got. Such things as stuffed mammals and birds, heads of game, butterflies, fossils, minerals, shells, glass, pottery, prehistoric and Roman remains, Egyptian antiquities, medals, coins and curiosities of all sorts form the staple exhibits. Sometimes the only objects related in any way to the town or the district are a few so-called "bygones." The watchman's rattle, the special constable's staff, the spinning wheel, the bone-shaker bicycle, antiquated umbrellas, hats, etc. These do, at any rate, belong to local history and are useful so far as they go.

If the visitor reflects on the nature of the main exhibits it will occur to him that they are precisely the things which it was the fashion to collect a hundred years ago. In those days a great many intelligent people made very considerable collections to gratify their own tastes, and those who travelled brought back innumerable curiosities from the countries which they visited. Most museums contain whole collections of this sort and their origin is pretty clear.

Look, for example, at the public museums owned by Municipal authorities. They usually began through a gift, or gifts, offered or bequeathed by their owners, and having been accepted by a public body, they were housed in some public building—at the outset generally the library—for lack of any more appropriate place.

In the first enthusiasm of a new venture, this nucleus has been increased by the addition of a number of gifts of collections or miscellaneous objects from private donors, and the museum, having been begun in this way, is continued by a process of miscellaneous accretion, even when it has ceased to be a room in a library and has a home of its own. Such gifts are not unusually of considerable magnitude and importance, and it would have been difficult for a town council to refuse them after once the museum was started on these lines. Even when a purchase grant has been made by the governing body, the policy of welcoming and accepting practically every gift has almost always been prevalent in the early stages.

The same process has generally prevailed in most other public museums, even those which were owned and administered by societies or associations. The result has been that, taken as a whole, the public museums of the country are remarkably like one another in general, and very few are particularly appropriate to the locality in which they have been placed. Their character has really been determined by miscellaneous donors. With most of these museums it is perhaps natural that in the early stages they should concentrate on mere acquisition; the necessity of filling empty rooms was the main stimulus; with the result that often the same process has been continued when it is no longer necessary, even when the space is beginning to be cramped. In fact, it may be stated in general terms, that most of the museums have suffered from the mere practice of acquiring exhibits (or even collections that cannot be exhibited) without any definite idea of the purpose to which they can be applied. There has been no clear policy to regulate the growth of each; and yet it is evident that the conditions vary so much between different towns and different districts that to be of real service the museum should adapt itself to the needs of its locality.

There is no reason why the same sort of museum should be established in a great city, a small town, and a village; in a manufacturing centre or an agricultural district; in a maritime port, or a seaside resort; if it is to render the greatest public service, it should clearly be appropriate to its neighbourhood, and should pursue an appropriate policy. If there is no particular characteristic that dictates the future of a museum required in a given district, the place has, at any rate, a history of its own, natural resources, or local conditions, all of which can be illustrated in the museum, and make it a centre of real interest to the neighbourhood.

To all the general statements which I have made there are notable exceptions, many of the museums situated in places where there have been historic or prehistoric discoveries disclosed by the archæologists have begun to concentrate to some extent on the prehistoric remains, or on the historic furniture and architecture, etc., of the neighbourhood. Some few have even begun to get rid of the often overwhelming and miscellaneous collections which have nothing to do with these.

Again, it is gratifying to notice that such places as Liverpool and Hull have begun to organise shipping exhibits; that Nottingham, Norwich, Stoke, Worcester, Luton, Leicester, and others deal with the industries for which the towns are, or have been, famous; that old houses and historic mansions which enshrine the history of the district have been preserved and in many cases appropriately furnished, as at Bolton, Stratford, Norwich, Ipswich, Birmingham, Bradford, Leeds, Shoreham, Southend, and other places; and that the houses inhabited by distinguished men, such as Shakespeare, Milton, Johnson, Cowper, Carlyle, Hogarth, Keats, Wesley, and others, have been preserved as far as possible in the original stae. A few museums have

definitely devoted themselves to some special purpose, and have an idea to inspire them: for example, the Educational Museum at Haslemere, and to some extent that at Ancoats in Manchester; the Home Office Museum; the Pitt-Rivers at Oxford, the Horniman and the two Wellcome Museums in London.

One must note, of course, that there are a considerable number of University and professional museums, and some belonging to societies or associations, which have been definitely established for the use of students, and a certain number, such as Lord Rothschild's Zoological Museum at Tring, the Bryant and May Collection in Bow of appliances for the production of fire, the old Ashmolean Museum at Oxford, were designedly limited to a special subject.

There are many signs of improvement in the general situation; but, when all is said, it must be confessed that the large majority suffer from over-exhibition, lack of policy, and the fatal habit of accepting miscellaneous gifts, so that of the service which they might render throughout the country a very small part is actually fulfilled by them.

The title of my lecture is "Museums and Education," and it is from the point of view of education that I must consider a little more closely the question: Why should museums exist?

Numbers of towns, large as well as small, have none, and they seem to be no worse for its absence. (In my report I gave a list of 112 towns with a population over 20,000 which had none; it is true that some of these are within easy reach of towns that are supplied, but this is not true of the majority).

First, what is the use of a museum? A partial answer is that to most people, grown-up as well as children, sight is everything; a mere description without a vision of the thing described falls on deaf ears; even a picture of it does not make full appeal to the eye. Some persons have minds so constituted that this is the only way in which they can acquire real knowledge; they are not readers, they have no eye for diagrams, but they are keenly alive for actual experiences.

Even to people who are fond of reading and of pictures, nothing can replace the interest of the genuine thing. Learning is enlivened and made far more effective if visible objects are brought together with a purpose. In subjects like natural history this is obvious; in ordinary history it is equally true. Look, for example, at the room illustrating Greek and Roman life in the British Museum, or the exhibits at Huddersfield explaining the history of the settlement of that district by its early inhabitants; or the history of discovery as illustrated in the Science Museum.

But in addition to this is it not true that only in our museums are to be found the visible materials of history, science and art; the things about which we read but which we could only otherwise see by making long journeys? Many, indeed, have perished and are only preserved in museums. Bear

this in mind and the question is not, How can the museums be of service in education? but rather, How can education get on at all without the museums and the first-hand knowledge which they supply? They are not filled with dull things that have no concern with ordinary life and learning, as some people imagine; they abound with material that is the very foundation of knowledge in almost every conceivable subject.

The educational question is beset by one great difficulty. Most educational institutions are designed to serve some particular class of people or to fulfil some particular purpose; they are meant for children, or for students of a certain age, or for persons with a certain aim before them. Museums and Art Galleries, though their educational possibilities are enormous, resemble the broadcaster in that they serve a vast unknown public; they are frequented by persons of all ages, types and classes; most of these do not say what they want, and it is impossible to ascertain what knowledge they have gained, or even how far their curiosity has been satisfied.

If, however, visitors can have their imagination stirred; if the spirit of enquiry can be kindled and satisfied, then the exhibited collections are doing real educational work.

In many museums of the country there are learned and hard-working curators doing their best, often handicapped by miserable pay, lack of sympathy and abundance of misunderstanding, but doing their best to make their collections attractive and useful. I have said a good deal about the defects of the worse museums, but much might also be said about the treasures and their effective display to be found in the better museums and art galleries

The new art of window dressing in shops is cultivating a taste for spectacular display, and a good museum exhibit can compete even with the shop window; it also makes its appeal to the eye and relies upon its power of attraction. The shop window serves its purpose when it tempts the gazer to come in; the museum when it tempts the visitor to think.

The term "curio" is one of reproach; but, after all, it only means an object which stands alone, out of harmony with its surroundings and therefore unable to serve any purpose, whereas it could, in the proper place, be interesting and educational. The coin in lava or the special constable's staff are of no use to the ordinary visitor unless they excite interest and prompt a question which is answered by the adjoining exhibits or by a good label. Even a rare animal in a magnificent case is only a curio if it stands alone and leads to nothing; visitors admire it and pass on; and though it is true that to encourage a love of beauty is one of the great objects of a museum, as well as of an art gallery, something more is needed.

Everyone who has been taken through a museum, or even one of its rooms, by an intelligent curator, knows how interesting it can be made by him in a few minutes; but few visitors can enjoy this privilege, and very few museums can afford the inestimable benefit of a guide lecturer.

Failing this, and apart from the value of a museum as a storehouse of material for special study, everything clearly depends on the manner in which the objects are selected, exhibited and explained.

And this brings me to a second question: What should a museum try to do, and how? For whose service is it designed?

Consider, for example, the Municipal Museum in a large town with a large space for exhibits, within easy reach of a good library and probably situated in a much frequented quarter. This has to serve, in the first instance, the needs of ordinary visitors, who come in, often with no particular purpose, and only rarely with the object of seeing any particular thing. From the enquiries which I have made it seems to be generally the case that about 60% of these visitors are not inhabitants of the town itself, and in these easy days of transport a very considerable number are mere passers-by, who pay quite a short visit.

In the second place, there are the needs of the schools of the district to consider. Sometimes school visits are organised in which classes are under the guidance of their own teacher, or lectures are provided for them. In some instances the museum is able to lend specimens to the schools and even send out boxes with sets of objects specially arranged and labelled for their use.

In the third place, such a museum has to consider the needs of collectors, experts in special subjects, and persons who come to make quite definite enquiries; and, lastly, there may be persons who wish to make use of the resources of the museum, and conduct researches within its walls. This last class is, of course, rare, and in most places hitherto non-existent.

Is it not obvious that every exhibited object should be displayed for the advantage of one or other of the different classes of visitors who may be expected? Let us consider what this means.

First, with regard to the ordinary visitor: in my opinion a quite definite policy should guide the curator and his committee. The exhibited collections should, if possible, relate mainly to the history, the nature and the resources of the town or district, and other exhibits should, so far as he is concerned, be subordinate to these, and should serve to illustrate them whether by comparison or contrast.

It is most important that the visitor should on entering the museum be greeted by exhibits which arouse his interest, something characteristic of the general collections which he is about to see. A case containing latest acquisitions is generally useful in challenging the interest even of residents to whom the collections are fairly well known. An exhibit relating to something of contemporary or local importance can be very attractive. Very few museums took advantage of the eclipse the year before last.

Further, each museum should have a character of its own. This will depend on the curator, and will be one of his chief cares. If it changes with successive curators, so much the better.

For the visitor who is not a resident there should be plenty of direction-labels

and plans, clearly indicating the arrangement of the sections and the order in which they may best be visited. The larger the museum, the more important is this. It is pathetic to watch the attempts of a casual visitor in a large museum to get something definite out of a short visit.

In his tour through the collections he may, for example, pass suddenly from an exhibit of china or glass to cases containing flint implements and prehistoric remains, and from these to shells. Unless there is something to prepare him for the shock he can with difficulty turn his mind from one age and subject to others which are totally different, and he needs some well-chosen specimens arranged and labelled so as to explain what is coming next, before he is overwhelmed by it. His visit is a series of such shocks, and I believe this to be the main source of museum headaches. (This is equally true of many picture galleries, where artists and schools succeed each other with bewildering rapidity and without explanation, or are inextricably mixed.) No wonder that he contents himself with a hasty search for something exciting.

Where the sections are large there should surely be at the beginning of each a case or series of cases containing a short, well-spaced, well-labelled introduction to the section. For a first visit, or for a chance visitor, these introductory series give almost all that is required, but they should be of such a nature as to stimulate in him the wish to see more of the collections.

I need not refer to the great value of guide-books, " What to see " leaflets, special handbooks, photographs and postcards, such as are issued by many of the better museums. The large sales which they generally secure shows how they are appreciated by the public. Lectures and qualified guide lecturers should be encouraged and every museum should, where possible, have a lecture room The work of Lord Sudeley and, since his death, of the Sudeley Committee has roused much interest in these matters.

We come next to school children or adults who seek educational guidance It is in particular for this class that these introductory series should be specially designed.

When the educational use of a museum is discussed one is too apt to think of this merely in its application to school children. In reality its educational responsibility relates to grown people as much as to children . like a library, the museum exists for adults as well as children to use at their own times for voluntary self-education. That is why the exhibits must be not only well chosen but also well explained for both. The construction of lucid labels is a very difficult task and one which requires much care and thought. Moreover, they must be conspicuous though not aggressive, and must be placed where they can be easily read. This is a particularly difficult problem, where the objects are works of art exhibited largely on account of their intrinsic beauty, and where a label, unless cunningly designed, may break the harmony of the display.

I would not wish, however, to lay down any fixed principles for educational exhibits or loans to schools. This is a matter in which the curator, with the help of school teachers, should devise his own methods in order to meet, as far as possible, the special needs of the schools and the district. It is always a help and encouragement when references to the books which may be consulted in the library are placed near the exhibits.

It is curious that collections set apart for the enlightenment of children, as at Bethnal Green and at the Tollcross Museum in Glasgow, should be so rare; they might be very useful, and children might be encouraged to contribute to them by collecting.

Visitors belonging to the remaining categories, *i.e.*, the collectors and researchers, should find what they want in systematic collections following the introductory series, and in the reserve collections; in these last the objects should be just as well arranged, and well labelled, and as accessible as those in the exhibition cases.

To carry out a full scheme on these lines would involve, in a great number of large museums, very radical changes. The exhibited portions would have to be drastically weeded out, and perhaps a majority of the specimens transferred to reserve, or exchanged away. This is, to some extent, being done in a few museums, and it is most instructive to compare those parts of such collections which have been thinned out and re-arranged, with those parts in which the old congestion prevails.

In almost every museum, however, a beginning might be made, and the process be continued as opportunity occurs.

To preserve an atmosphere of vitality, it is of the highest importance that constant change should be taking place in the exhibited collections, whether by the transference of material from reserve to the show cases, or by means of temporary exhibits obtained by loan from other museums. Everyone knows how an art gallery in which the same pictures hang in their accustomed places year after year, is liable to become stagnant, and how much it is re-vivified by the appearance of a loan collection of special exhibits from time to time. In a museum it is more difficult to clear a room and make space for a special loan collection; the objects are also more difficult to transport than pictures. Still, a great deal may be done by the temporary exhibition of special objects that fill a gap in the ordinary collection, or make them, for the time being, more interesting and useful. The Parliament and Premiership Exhibition at the London Museum is a recent example. A very helpful part is played by the cases received on loan from the Victoria and Albert Museum in those museums which share in its distribution system. It is generally found that the advent of a new case attracts an increased number of visitors.

With regard to research, although at present very little is, or can be, done directly, the mere existence of reserve collections is of great help to the local collector or enquirer, and this is especially true of museums already associated

closely with such bodies as archæological and natural history societies. If these can actually hold their meetings in the museum's premises, and organise visits to it, opportunities will gradually grow up for research into local history and conditions, specially, in the first instance, by organising a regional survey. Work of this sort has a high educational value.

Next, with regard to museums in small towns or villages, it will almost certainly be wise for the great majority to specialise entirely, or almost entirely, on (*a*) local interests, and (*b*) educational purposes. If collectors and investigators cannot have their difficulties solved they should be sent on from the small town or village to the large and more central museums. A really good local collection, and one which becomes a delight to the inhabitants of the neighbourhood, is of far more use in such places than any number of miscellaneous specimens, such as the foreign material, the ethnographical and archæological lumber from distant parts of the world, and the travellers' gifts, which so often cumber these small museums. In most of them a very radical reform is needed.

The museum should, where possible, act in close co-operation with the library ; this need is particularly obvious in the case of technical and commercial libraries. Librarian and curator can be of the greatest assistance to each other. The arrangement by which they are the same person, though very usual, I can only regard as a temporary expedient, at any rate in the larger towns.

It will, however, be impossible for the country to develop anything like an organised museum service until each museum is able and willing to help others to supplement their needs. If the vast mass of material which is not wanted in each museum could be transferred or lent where it can be used, and if the larger museums could institute a system of loans or circulating collections to the smaller towns and villages, the existing material which at present serves no special purpose, might become effectively useful throughout the whole country.

It is difficult to see what is gained by occupying valuable exhibition space with a rare collection of type fossils or of Peruvian antiquities in a museum where there is no prospect of their ever being used.

For many years past the deficiencies of the museum service have been very widely recognised, and there have been constant complaints concerning the needs of local museums and their difficulties in obtaining the support which they require in order to carry out even their duties to the district. The demands for an enquiry into the whole system have been frequent, and it has been more than once suggested that a Royal Commission should be appointed for the purpose. Conscious of these claims the Carnegie United Kingdom Trust summoned in June, 1926, a Conference of the various bodies likely to be most interested, in order to discuss the situation ; the conference was attended by persons representing many interests, and it was suggested that an enquiry

should be held by the Carnegie Trustees themselves. I was invited to make this enquiry on their behalf, and visited a large number of the museums of the British Isles. I submitted to the Trustees a Report which was published in April, 1928, and which has been widely circulated to museums and to persons interested in them.* .

It will be remembered that the Carnegie Trustees pursued a similar course when they invited Professor W. G. S. Adams to inform them on the Library provision of the country, and received from him a Report which was published in 1915. It will be remembered, also, that as the result of this enquiry and the subsequent action on the part of the County Councils and the generous assistance of the Carnegie Trustees, the whole system of County Libraries was instituted, and that this brought the library service of the country, for the first time, within reach of the rural population. The library service of the country has been strengthened by two other factors: first, the increased power and authority of the Library Association, which now represents every important library in the Kingdom, and, second, the establishment of the Central Library for Students. This library, which was originally instituted to lend books to members of the Workers Educational Association, and the University Tutorial Classes—in other words, to supply the needs of poor students—became, with the help of the Carnegie Trustees, a very important organising centre. It is now performing an even more striking service than that for which it was originally constituted. It has associated with itself a large number of the special libraries of the country. Any student needing a book not to be got in his district can now apply to his own local library. This in turn applies to the Central Library, which gets the book for him from one of the affiliated institutions. This really constitutes the first attempt to organise special libraries, such as those belonging to scientific, literary and artistic societies, for public service.

Turning now to the museums, it will be seen that there is, at any rate on the surface, a remarkable parallel. There is a Museums' Association, which at present only represents about one quarter of the museums of the country. Until it becomes as fully representative as the sister association, it can hardly expect to be as effective as the latter has become. The rural population derives no more benefit from public museums than it derived from public libraries before the institution of the County Libraries, and there is no more co-operation between individual museums than there was between individual libraries before the institution of the Central Library. It is, therefore, not surprising that some of the suggestions to which I was led in the course of my enquiry closely resemble the improvements which have been instituted into the library service.

*The fact that a Royal Commission was appointed in July, 1927, to enquire into the National collections situated in London and Edinburgh made it advisable for me to exclude the National Museums from my Report, and prevents me from saying much about them here.

The Museums Association should be strengthened; it should become fully representative; it should be able to secure the consideration of better scales of payment for curators and their staff; it should be able to establish a standard of education to be attained by all those who enter the museums' service; local authorities should endeavour to co-ordinate the activities of the museums within their area, and encourage them to contribute by loans and personal assistance to a system of travelling collections to serve the educational needs of rural districts; museums, like libraries, should, where possible, be open in the evenings.

These recommendations will be found in my Report. It has frequently been urged that there should be some central or national distributing agency which could organise the loan of much needed exhibits to all the important Public Museums of the country. It has generally been assumed that this would involve a great central collection established for the purpose. Sometimes it has been thought that the National Museums themselves should be constituted the central lending agency, and should send out what they can spare from their own treasures on loan to the various museums; in fact, that they should carry out on a larger scale the work that has been done by the Loan Department of the Victoria and Albert Museum, or even that the work of that Department should be extended so as to include all sorts of museum objects. At present the Victoria and Albert sends out cases of exhibits relating to applied art to about eighty museums, which keep them for about fifteen months until their contents are changed. These cases, however, do not contain objects selected from the great collections of the museum, but come from a special store kept for loan purposes.

The Victoria and Albert also administers a small grant of a £1,000 a year from which other museums are assisted to purchase desired objects; and, further, it sends out loan collections of Decorative Art to no less than 550 schools in the British Isles for educational use.

The question of gifts and even of loans between museums is complicated by the fact that those whose material is constantly being used for purposes of research and reference possess comparatively little that can really be spared. Among National museums the British Museum is, of course, the most conspicuous example; University museums and a few of the great provincial museums to some extent come into the same category in respect of both research and teaching material.

I cannot help thinking that a liberal system of loans, between the National, the larger provincial, and the smaller local museums which are really endeavouring to do good work, would be very helpful. And exchanges, which might when necessary take the form of permanent loans, would be useful to almost all the museums of the country.

But to carry out any such scheme of organisation means a complete change in the attitude of mind on the part of the public, of the curators, and of the administering Committees.

The public must learn to take a pleasure and a pride in their museums, to use them and to give them their support; the curators must resolve not only to make the best possible use of their materials, even to the extent of sacrificing some of them, but must consider their duty to the country as a whole and be prepared to give and to exchange as well as to amass; the Committees must get the best available curators, pay them adequately and supply them with assistance.

If I seem to have criticised unduly the curators and administrators, let me add that, in my opinion, the general public really deserve most of the blame. The museums, with all their treasures, belong, for the most part, to them, and it is their fault if these are not used as they should be. Let people go round and ascertain how far they can learn from their own museum. Let them see that it becomes an institution of which they may be proud.

The real test to be applied to the exhibited collections is to ask concerning each object: Why is it here, and what purpose does it serve? If this question cannot be satisfactorily answered that object had better be turned out.

An unlabelled object, or a mere duplicate, or one that cannot be seen or understood, if placed among the exhibits, is not only useless, but is a positive harm to the museum.

The test to be applied to the museum as a whole is to ask the question: What is the idea behind it, and what is its aim? If this question cannot be satisfactorily answered it had better be closed.

Great systematic collections should only be in places where they can be used, such as the National or the University Museums, or in such as have a trained staff; there they can be at the service of experts and specialists, or be used for teaching purposes.

So long as mere collections of objects unexplained and unrelated to each other exist only to weary the visitor, so long will the public be prejudiced against museums. The manner in which they are misunderstood is indicated by the offers which they occasionally receive. Even a great National Museum has been offered " two joints of meat cut and hung on the day Queen Victoria was crowned; " and donors have proposed to present objects to it which were stated to be only fit for a museum.

My report to the Carnegie Trustees also called attention to the extraordinary deficiency in certain types of museums, such as Agriculture, Hygiene, Shipping, Industry, Commerce, which would certainly appeal to large classes of the community, if not to all.

Again, the absence of any worthy Museum of Sculptural and Architectural Casts is a disgrace to the nation. It is true that there are collections at the Victoria and Albert, the British Museum, the Crystal Palace, in addition to the teaching collections at Oxford and Cambridge, but there is nothing to compare with many to be found abroad. In casts of Greek and Roman

sculpture, for example, we are far behind, not only Berlin, but such towns as Munich, Copenhagen and Boston. Except for its position no existing building seems to me better suited for a great collection of casts than the Crystal Palace.

There is one missing type which is particularly urgent and to this I would like to devote the few moments that remain to me.

Last year I visited the small town of Arnhem, in Holland. There, in 1912, an association was formed which collected material for a National Museum to illustrate the former life of the Dutch people. A large park was provided by the Municipality; it was decided to exhibit not only objects relating to the art, industries, occupations, and customs of the folk, but also the actual houses in which they lived.

There is now in this charming park a museum building containing domestic material and the other things usually known as "folk" exhibits, illustrative of peasant art and industry. In addition, dotted at intervals about the park, are old cottages and other buildings; these are in no case imitations, but are actual structures transplanted from different parts of Holland and re-erected in a new setting.

Here you may see, for instance, a seventeenth century farmhouse, with its thatched roof, its loft, its blue painted wattle walls, its fire hole in the ground, and its two tiny rooms, little more than cupboards, containing the looms at which its weaver inhabitants carried on their cramped trade. In another part you may see a fine tiled early eighteenth century farmhouse with its proper equipment and furniture; further on are waterwheels and windmills belonging to different periods and different types. You can go into them and see their antiquated wooden machinery. The cottages and other exhibits are numbered in order, outside each is a bench, and a receptacle for lighted cigarettes and cigars; there are no caretakers; visitors can wander through and see everything for themselves; there is an excellent guide-book.

The central portion of the park is cultivated, and contains the garden of a botanical society and one belonging to the pharmacists. There is an open air theatre for popular representations, folk dances, etc. The whole place is aptly called the "Open Air Museum."

This is only one of several such museums to be seen abroad, of which Skansen, at Stockholm, is the earliest. A similar one, for example, was started by private enterprise at Aarhus, in Denmark, in 1924.

In England there is nothing of the sort, and the houses and materials from which an open-air museum might be constructed are rapidly disappearing. It is not too late to save the few that remain if action is taken without delay.

Here and there, as at West Hoathly, at King's Lynn, at Thetford, and at other places, most interesting old houses have been secured by the enterprise of individuals, and have become museums of contemporary "bygones." Near Hull an ancient Tithe barn has been recently utilised for the same purpose. And

the Royal Society of Arts itself is doing a great work in purchasing old cottages and houses which are in danger of destruction, in various parts of the country.

But there is no real " Folk Museum,"* to depict the life of English people through the ages ; old mansions and the treasures which they contain when they have been converted into museums perpetuate and enshrine the Fine Art of their periods, generally the property of the rich and in large part the work of foreigners. The Folk Museum would restore to our sight the work of our own countryman, and the conditions under which it was carried on ; their industries and industrial art, their adornment and their architecture.

If public or private enterprise can find the means there should be a National Museum of this type situated in the London area, in some such site as the Botanic Gardens in Regents Park, or the sixty-six acres of ground surrounding Chiswick House, which has recently been acquired for the public.

Finally, to recapitulate, I have made a number of suggestions about needed improvements in the museum service ; most of them involve largely increased expenditure, on improvements in buildings, on the provision of storage space, on increase of staff, on proper salaries for curators and their assistants, on guide-books, labels, lecturers, special collections ; but I have not concealed my opinion that very imperfect use is made of the existing material, and that even under present conditions a great deal could be done by a widespread co-operation which does not yet exist. A local federation of museums in Lancashire and Cheshire is of recent origin, and is doing something ; the museums of Wales are almost all affiliated to the National Museum at Cardiff ; this is a beginning. Other local federations and affiliations would be welcome ; but, in addition to this, all the museums of the country should combine for common action; they should make their Association a completely representative body by becoming members of it ; they should authorise it to act on their behalf in organising a real museum service, and enabling them to assist each other ; they should co-operate in seeing that all curators are properly trained ; in stirring up public appreciation of museums and their work ; they should enter into closer relationship with the Library Association. The County Councils should take in hand the extension of museum facilities to the rural areas, though for this, I am told, new legislation may be required. Collectors and donors should see that their collections go to museums where they are acceptable and where the best use will be made of them.

Except in a few conspicuous places, there seems to be so little pride in museums ; the main mass of the public are scarcely conscious of the treasures that they possess.

I have immense faith in the great service that can be rendered by our museums ; I am confident that they possess untold resources and vast possibilities, I believe that it is only necessary to stir the public imagination and they can easily be made one of the great educational forces in the country.

*The name " Folk Museum " is commonly used in two different senses : either as meaning an open-air museum of the sort which I have described, or a building containing exhibits illustrating peasant arts and industries such as the Scandinavian Folk Museum at Haslemere.

DISCUSSION.

Sir Frederic Kenyon, G.B.E., K.C.B. (Director and Principal Librarian, British Museum) said the paper was a challenge both to all those who were connected with the museums of the country and to the public. The lecturer had made it quite plain that the country was not getting value for its museums at present. They were in a backward state, and a great deal of admirable material was being wasted. The public authorities responsible for museums had now to ask themselves the question whether they were going to make their museums live and useful institutions, if they were not so at present, or whether they were going to close them down. There were many museums which were doing excellent work, but there were a good many which were not. The key of the matter was in one sentence of the lecturer's, in which he said a change of mind was necessary. "Change of mind" was the proper translation of the word "repentance"; the authorities and the public had to repent of their previous attitude towards museums and to adopt a changed mind in future—to realise that there was a good deal to be got out of museums, and to think how they were to get the best out of the particular museum with which they were concerned.

The report of Sir Henry had been made for the Carnegie Trustees, and it was to be assumed, therefore, that that body was interested in the matter and would be prepared to consider what they could do to help museums in the future, as they had helped libraries in the past. The Carnegie Trustees had not bound themselves to the proposition that they were going to do anything; they had only so far said that they would, on the basis of Sir Henry's Report, consider whether there was anything practical to be done; and he took it that the conclusions to which they would come would depend a good deal upon the principle which they had followed in the past, namely, that they were only prepared to help those who were prepared to help themselves. Personally, he suggested that the best way in which the Report could be followed up would be if the Carnegie Trustees could see their way to appoint one or two permanent advisers or inspectors who would be ready to put themselves at the service of museums which wanted to improve themselves. The difficulty at present was that many local curators did not know how to make the best use of their material. It was a matter requiring a wide experience and a knowledge of other museums; and in many cases those individuals would be grateful for advice from an expert. Possibly the Carnegie Trustees would be prepared to assist those museums which were willing to progress along the lines pointed out to them by an expert adviser. The changes necessary would in all cases involve some expenditure, and local authorities did not command unlimited funds, but they might be willing to provide them if they knew those funds were going to be supplemented from an outside source. At any rate, he could not help thinking that there would be a great stimulus behind some such scheme as that. A second point was that of a central pool, or central loan museum. The lecturer had emphasised the value of novelty in exhibition, and for many museums the best form of novelty would be some kind of loan collection which they could hold for a time, combined with their own material, since the public were more likely to come when they knew there was something new to be seen. It was possible, if there were central advisers who had a general knowledge of the museums of the country, to do a great deal in forming loan collections out of the surplus material possessed by a number of museums. A good deal of material which was now described as waste material was waste material simply because it was good material out of place. It was no good looking to the national collections themselves as providing material for the sort of loan collections of which he was thinking. The

national collections, and the collections attached to the great universitie entirely for educational purposes. It was a mistake to suppose that such instit had any large surplus stores which were available for distribution. They requi for scientific purposes, to retain large quantities of material which the stude could find there whenever he wanted to.

MR. ERIC MACLAGAN, C.B.E. (Director and Secretary, Victoria and Albert Museum) stated that his remarks would not in any way be in the form of criticism of what the lecturer had said—very much the reverse, because all those who had the welfare of provincial museums at heart realised that Sir Henry was probably the best friend which the provincial museums ever had had in the course of their history. Personally, he had often felt that the English provincial museums were unfairly criticised. Comparisons were made between them and the museums in the small towns of France, Germany or Italy ; but the conditions in England were completely different. If one came to analyse what was to be seen in the museums of the smaller towns abroad, it would be found in almost every case that those collections represented either, in the case of French local museums, the spoils of plundered churches and monasteries, or, as in the case of German and Italian local museums, the remains of local princely collections. Neither of those conditions prevailed in England. When there did exist an English museum which, for reasons of local archæology, had got first class material (Dorchester Museum, for instance) it was quite on a level with what was to be found in any museum on the Continent.

He thought it was not quite fair to compare museums with libraries in the way in which they were managed. It was much easier to run a public library than to run a museum. It was quite easy to buy good books, but it was not at all easy to buy good museum objects, which required not only money but knowledge. He quite agreed that a good deal of responsibility in the matter rested on the public. The public, once they entered a public building, seemed to become incredibly stupid. An ecclesiastical friend of his had told him that it was extraordinary how a congregation lost all their common sense the moment they entered the doors of a church ; and he himself had sometimes been tempted to suppose that a good deal of common sense was lost by the public when they entered the doors of a museum ; they were curiously slow at times to take advantage of the opportunities which were offered to them in provincial as well as in national museums. In a somewhat similar way, with regard to that most interesting problem of the relation of museums to children, he did think that a certain amount of blame must be put upon the educational authorities as well as on the museums. When he had been in America and Canada he had been very much struck at the way the actual lecturing to the children was, nearly always, done by school teachers and not by museum officials. There was a certain truth in the idea that what the museums mainly had to do was to supply the material, and that it was really up to the public and up to the instructors of the children to take advantage of that material, and that everything had not to be done by the director of the museum.

THE RT. HON. GEORGE N. BARNES said he was one of those people who, up till that night, had known nothing at all about museums. He had always regarded them much in the way which had been described by the lecturer—as unattractive collections of unrelated articles, except to a specialist in some particular thing. It was, however, a tribute to the lecturer that he had made the subject most interesting, even to himself. In his own native town in Scotland he remembered the museum and the library being in one building, and they closely corresponded to the description given by the lecturer. The museum was a good place to hide oneself away from the madding crowd or to get protection from the inclemency of

the weather, whereas in the library one found an interest in the books. Sufficient had been heard that night to indicate that museums might be used as auxiliaries to education. It seemed to him that they might be of special value from a utilitarian aspect, and good use might be made of them in regard to the industries of the particular towns in which they were situated. After all, we lived in an age of specialisation, and in a town which specialised in some particular industry the boys could not be expected to be interested in old fossils and relics of bygone generations having no relation to the town's particular industry. Take the evolution of tools, for example. He had been in some of the museums in the industrial centres in the North of England, but he had found very little there to interest the people of those towns in the industries by which they got their living. One would think that in a town such as Manchester which lived on tools very largely,, there would be a museum showing the evolution of those tools from early times. Many other illustrations could be given. It seemed to him that if a museum was going to be made a real adjunct to the educational machinery of the country, something of that kind would have to be done to relate the museum of a particular town to the industry by which the people of that town got their living.

Colonel Sir Henry Lyons, F.R.S. (Director and Secretary, Science Museum) said the previous speaker had referred to museums representing their local industries. Though there were not a very large number of those, it was an aim which it was to be hoped would be largely extended. There was no doubt of the interest of the public in industrial and technical exhibits. At the Science Museum there was a series of such exhibits as those to which Mr. Barnes had referred, and he could assure Mr. Barnes that it was a very remarkable thing to see the way people from the North of England, who had come to London to see a cup tie, for instance, streamed into the galleries containing machinery and appliances with which they were familiar in their work, and inspected them with the greatest possible interest. That went to prove that those people would be glad to have a further development in that direction in their own local museums. That part of museum work was especially affected by what the lecturer had said on the educational side of the subject. Few things in technical museums were in the least attractive in themselves and consequently until the public was led to take an interest in them—that was to say, until they had some small knowledge of them—they would not really appreciate what they were there for. In museums of that class, as in any other, it was essential that information, carefully edited, should be placed within ready reach of all visitors. He only wished that the public, when they did visit museums, would be more critical, and would draw attention to things which either they found unsuitable or insufficiently attractive to them. It was not difficult to pick up a good deal of information by watching the public on a crowded day and to see where they stopped and looked at things, and where they did not. Where they did not stop at the right objects, there was usually something wrong in that particular place with the curator's arrangement, which could probably be modified, and modified effectively.

Mr. G. E. Dibley (East Gate House Museum, Rochester) asked if there were any statistics available in connection with the opening of museums in the evening for working people. It would also be very valuable if the lecturer could insert in his report a recommendation that municipal authorities should be advised to appoint really suitable persons to serve on their museum committees.

Professor Graham Wallas said he had only one suggestion to make, and that was with regard to the use of reproductions as part of a series of exhibits

Many museums had a single authentic coin which, if it was placed in a series of electrotype reproductions, would be of the greatest possible value. The same applied to stone implements. A single stone implement was of very little interest, but if it was placed in a series of exact reproductions showing prior and successive periods of the evolution of those instruments, it would be extremely valuable.

Dr. Francis A. Bather, F.R.S. (Late Keeper, Department of Geology, British Museum) said the author had brought rather an indictment against provincial museums, and those who managed them and those who visited them. He admitted numerous exceptions. When it was considered how that state of things was to be altered it was found that there was a vicious circle. In the end the lecturer had said it was the fault of the public. Why did not the public take an interest in museums? Because they were not interesting. Why not? It was not the fault of the curators. There were many such men and women who did their utmost to make their museums interesting. It was the fault of the committees. The committees were individually excellent people, but they did not get enough money. Why not? Because the public did not want to pay the money. Why not? So the whole thing went round and round in a vicious circle. What was to be done to get out of the difficulty? Everyone had hopes that the Carnegie Trustees would do something to break that circle Sir Frederick Kenyon had made some valuable suggestions how that could be effected. Personally, he merely wanted to emphasise the fact that there really were a great many museum people in this country who did their utmost to make their museums interesting. Foreign provincial museums might, as Mr. Maclagan had said, be richer in material, especially of art, than corresponding museums in this country, but in respect to the educational use made of it the musems in the ordinary small provincial towns of the Continent were not anywhere near the same level as those in English provincial towns. There was not a single museum in France, for instance, which was doing anything like many English provincial museums in the way of instructing the public and of making the exhibits interesting to the public. Most of the museums abroad were excellent institutions for the specialist but did nothing for the general public. He urged school teachers to make more use of the museums, and, after a history lesson, to take their pupils to see the particular specimens of the period of history dealt with. For instance, if the pupils had been reading about Queen Elizabeth, it would add greatly to the value both of the lesson and of the exhibits in the museum if the teacher took them to have a look at the things in the museum which had some connection with the Elizabethan period. With regard to the Scandinavian open air museums to which the lecturer had referred, a Swedish friend of his had remarked to him, "What is the good of having an open air museum in England? England is already an open air museum. You have got these old houses everywhere. Do not bring everything together into one great museum. The objects are of greater interest when preserved in or near the places to which they belong."

Miss Marian Frost (Curator, Worthing Museum) said she happened to be curator of a small museum and of a library as well, and she would like to say that she thought the reason why libraries in this country were so much better run than the smaller museums was largely because of the assistance which the Carnegie Trust had given to rural library schemes, and also because of the fact that in earlier days Carnegie had given so much money for library buildings. There were many curators who would have their museums in very much better order if they had a little more money and room. With regard to the point of unsuitable objects in museums, in a small place it was extremely difficult to refuse unsuitable gifts as it might mean

the loss of a subsequent suitable gift. All curators of museums would like to follow the example of the beautiful museums in Copenhagen, where one picture or one bronze was put in a single room, but unfortunately they had not the space, and therefore had to crowd the objects together. As she had said, if curators had more money and more room, they could certainly make their museums very much better.

SIR ATUL CHATTERJEE, K.C.I.E. (High Commissioner for India) said he had come to the lecture knowing very little about museums, but he had learned a very great deal during the course of the evening, not only from the lecture itself but from the most instructive remarks of the very distinguished speakers. From the point of view of a person who went round museums without knowing anything about the subjects displayed, he would like to say how much he had appreciated the lecturer's suggestion regarding labels. He had often seen things which he had not understood and about which he wished to know something, but in many cases there had been no useful labels attached to those objects for the instruction of ignorant persons like himself. That was a point which he thought should be attended to by all curators of museums. Another point which had struck him was the fact that no reference had been made to any museum which educated the people of this country in regard to the resources and the various details connected with the British Empire. There was, of course, the Imperial Institute, but all knew how deficient that was in many respects, and the present management under Sir William Furze were making most strenuous efforts to improve the condition of that institution ; nevertheless he could not help thinking that it would be a very useful thing if local museums all over the country gave more attention to displaying, for the benefit of the local public, facts and objects connected with the life and conditions of the different parts of the British Empire. That would be a most desirable thing, not only from the point of view of the British public, but also from the point of view of the inhabitants of the various parts of the Empire.

MR. C. J. FFOULKES, O.B.E. (Curator of the Tower Armouries) said that the lecturer's suggestion that museums should help each other by handing over certain specimens which were not of particular value to them, was one in which he was particularly interested. He was engaged in an endeavour to sort out various military exhibits in several museums under Government control some of which were absolutely unknown to the public, though they were of extraordinary interest from the historical point of view. He hoped that when these re-arrangements had been carried into effect the several military museums under Government control would be of more use to the student and more interesting to the general public. He, too, desired to emphasise the importance of labels. His experience was that the public would pass an unlabelled exhibit but would at once stop and examine a labelled exhibit. If in addition to the label a photograph of the exhibit in use, and perhaps a map of the locality in which it was used, were appended, there was no doubt about the visitor's attention being arrested. One very important point was to see that the attachment of the label was perfect. Very often a label came off, and the attendant picked it up and affixed it to the nearest object which had no label, with some resultant confusion ! He desired to put in a word for the public, because he was perfectly certain that, if objects were shown in a right and attractive way, the public would be quite ready to appreciate museums.

MR. HARGREAVES WILKINSON (Public Library and Museum, Rawtenstall) thanked the lecturer for many of the hints he had given. As a member of the

Lancashire and Cheshire Federation he could speak most highly of what the distribution of duplicates had done in Lancashire and Cheshire.

THE LECTURER, in reply, said there had been little said in the way of criticism. He had been hoping that some of his suggestions would have been adversely criticised, but the audience on the whole seemed to have agreed with what he had said. He believed very much indeed that there was a real need for the evening opening of museums, but it had been the unfortunate experience of some places where museums and other institutions had been opened in the evenings that they had not been used by the public as much as had been expected. He also agreed that it was extremely important that museum committees should co-opt persons who had special interest in museum work. Professor Graham Wallas had suggested the use of reproductions. The use of reproductions was coming in more and more, and they were extraordinarily useful and serviceable in filling gaps and making the authentic objects far more interesting. With regard to Dr. Bather's friend's statement about the undesirability of moving houses from their natural surroundings and putting them into an open air museum, unfortunately the choice was between saving them for an open air museum or letting them be destroyed altogether. A great number of such houses had already been destroyed and a great number more were in the process of destruction. Sir Atul Chatterjee had drawn attention to the lack of a properly equipped Imperial Museum. There was nothing in this country to compare with the Colonial Institute at Amsterdam, where the whole of the products of the Dutch Colonies were exhibited in a most attractive building, which contained lecture rooms where colonial languages were taught, and to which anybody could go. He apologised for lack of constructive suggestions. His point generally was to urge that the museums and the public should get together, make a beginning, and lay down lines on which future progress could be made.

A vote of thanks to the lecturer having been carried unanimously the meeting terminated.

OBITUARY

H.H. PRINCE JOHN II OF LIECHTENSTEIN.—The death, on February 11th, of John II, reigning Prince of Liechtenstein, in his 89th year, at Feldsberg Castle, brings to a close the longest reign, if we exclude periods of minority, of modern European history. The late Prince, who succeeded to the throne on November 12th, 1858, in his 19th year, belonged to an ancient family of the Austrian nobility and was the tenth of his line to rule in the small Alpine State of Liechtenstein, which was purchased, in two instalments, by Prince John Adam of Liechtenstein in 1699 and 1712. The territory had previously consisted of two fiefs of the Holy Roman Empire, the Lordship of Schellenberg and the County of Vaduz, which for several centuries were held by the Counts of Montfort.

In 1858, when the late Prince succeeded his father, Aloysius I, the Principality was a member of the German Confederation, and was obliged, under the constitution of the Confederation, to maintain a military contingent in proportion to its population. In 1866, on the outbreak of war between Austria and Prussia, the Prince naturally took the Austrian side, and was a signatory to the treaty of Peace which brought the disastrous campaign to a close. The German Confedera-

tion having been dissolved, as a result of the war, the Prince of Liechtenstein abolished military service and entered into a customs, monetary and postal union with Austria, which continued until the fall of the Austro-Hungarian Empire. The reigning Prince of Liechtenstein, however, was so strongly entrenched in the affection of his subjects, that the only change brought about by the Great War was the substitution of a Swiss for an Austrian customs and monetary union. This arrangement did not affect the sovereign status of the Prince, who continued as before, to issue his own stamps and coins. The late Prince, who was well known for his patronage of the Arts, adorned his Principality with a number of fine public buildings, while he made of the gallery of the Liechtenstein Summer Palace in Vienna one of the finest private collections of pictures in Europe. He had been a Life Fellow of the Royal Society of Arts since 1892.

CORRESPONDENCE.

THOMAS GRAY MEMORIAL TRUST.

In the *Journal* dated February 8th I am interested to note a paragraph headed "Thomas Gray Memorial Trust--Prizes for the improvement and encouragement of Navigation"; and that the Society has been appointed residuary legatee for the purpose of founding the memorial.

Those who came in contact with the late Mr. Thomas Gray, C.B., in his official capacity as Assistant Secretary to the Board of Trade have a keen recollection of his ability with shipping matters, more especially on the question of lights and signals for the prevention of collisions at sea. The writer was at that time—some thirty-five years ago—actively engaged in assisting to codify the various signals for fishing vessels. About that time the question of steam trawlers and their various lights and signals had to be dealt with, as, under the heading of "Steamships," they were a new institution. The lights for fishing vessels became very perplexing when fishing operations were being carried on. A special light was suggested for the use of steam trawlers when towing their gear, and Mr. Gray obtained an Order in Council which made this light an official light for steam trawlers when towing their gear; this has been adopted by all nations. It is known as the Triplex Lantern, and is carried at the masthead when the trawler is at work. The settlement of this difficulty had been troubling the authorities for some considerable time, and Mr. Thomas Gray was credited with the solving of this difficult problem.

G. L. ALWARD.

APPLICATIONS OF ELECTRICITY TO MEDICAL PRACTICE.

Mr. G. G. Blake in his very interesting lecture on the Applications of Electricity to Medical Practice, published in the *Journal* on January 18th, omitted to mention the name of the late Dr. W. Deane Butcher, Editor of the Archives of the Rontgen Ray, as a pioneer of the Therapeutic Application of X-Rays.

From the year 1901 he treated patients in the London Hospital for Skin Diseases, in Fitzroy Square, as an electro-therapeutist, and in 1905 installed the X-ray apparatus by means of which he successfully treated many cases of lupus, naevus, etc., until the year 1914.

A. DEANE BUTCHER, F.R.S.A.

EXHIBITION OF APPLIED ART.

Exhibition of Handmade Fabrics and Pots, Mansard Gallery, Tottenham Court Road.—The greater part of the fabrics on view at this show are hand spun as well as hand woven. We are confronted with an important movement towards the humanisation of industry. Certainly, the crafts cannot hope to recover all the ground lost to the machines, but in a prosperous nation in future we may expect a vastly greater proportion of individual goods to be made and sold.

The first exhibit that one notices on coming into the gallery is the work of the Skye Weavers, formerly of the Island of Harris. The solidity of the technique here is the main attraction; but the skill and regularity of the simple woven patterns must not be overlooked. Much is made, throughout the show, of the intrinsic beauty of the threads and yarns used. Some of the German as well as the British craftsmen have left their rugs and other items undyed, the grey sheep produces a wool of fine colour, and in one case the black sheep proves no less inky as to his coat than he is imagined to be in the nursery. The most interesting German rug is by Miss Ella Lettre, of Dresden.

There is no doubt that Miss Enid Marx succeeds in imparting a most artistic touch to her work, which stood out from a very high average of exhibits at the recent Arts and Crafts Exhibition at Burlington House. Miss Marx suggests wood engraving in some of her patterns, which are none the less appropriate as decorations for curtains or skirts. She sometimes uses the discharge method of dyeing with excellent effect the material is first dyed all over and then treated by subtraction, not addition

Visitors should compare the more colourful work of Mrs Kennington with the monochromes of Miss Marx. Brighter again are the Assam silks of Miss Kitty Doncaster: these are hardier and coarser than our western silks The designs of Mrs Burder, themselves novel and attractive, would not be unsuitable for wallpaper; in fact, Mrs. Burder is preparing some wallpaper patterns, which are to be printed by the Curwen Press

Miss Barron and Miss Larcher are now well known for the work they have done in co-operation Among their exhibits is a fine design on muslin backed with linen. In general one is likely to be impressed by the success of the more geometrical patterns The modern genius seems to lie here: yet how dissimilar these repetitions can be is quickly appreciated if one compares a Nash design with, say, the Hungarian rug displayed in the outer gallery. There are reminiscences in this of the Orient and the South; no such associations cling to the best English work, in which a small unitary pattern is multiplied.

Somehow, although it is true that pots may have the appeal of shape in addition to attractive texture and pattern, the ceramic part of the exhibition is less fascinating than the textile. Mr. Alfred Hopkins deserves credit for his revival of salt-glaze stonework, but more on utilitarian than æsthetic grounds. His least fanciful work is the best; he shows a very simple and admirable flower-pot, as well as a too ambitious though highly skilful vase, with some such personage as Father Thames in relief.

A curiously regular level of good work is kept by Miss Braden and Miss Pleydell-Bouverie. It shows real æsthetic sensibility, and is seldom very striking; its merits grow on one. Michael Cardew has made a speciality of galena glaze, and has compromised not without dignity between the beautiful and the useful.

P B.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, FEBRUARY 25. . Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. R. W. Gregory, "Electric Supply to the Rural Districts of England."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture I).

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Paul Vacher, "Present Aspects of French Politics." (Lecture II).

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications." (Lecture I).

At University College, Gower Street, W.C. 2 p.m. Prof. Dr. J. G. Robertson, "The Romantic Age in Germany."

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture III).

5.30 p.m. Prof. Dr. R. W. Chambers, "Sources of Anglo-Saxon History." (Lecture VII).

TUESDAY, FEBRUARY 26. . Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. J. B. Charlesworth, "The Topoke of the Congo."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. R. A. Chattock, "The Modern Use of Pulverized Fuel in Power Stations."

At the College, Loughborough. 6.45 p.m. Mr. J. H. R. Nixon, "Motor Converters."

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. Mr. R. G. Collingwood, "Form and Content in Art."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture V).

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture III).

At King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture VII).

5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Motors to Heavy Traction." (Lecture III).

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical measurement of Light, with Biological Applications." (Lecture II).

At University College, Gower Street, W.C. 5.30 p.m. Lecture on "The Current Work of the Biometric and Eugenics Laboratories." (Lecture V).

WEDNESDAY, FEBRUARY 27. . Aeronautical Society, at the Engineers' Club, Manchester. 7 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

British Academy, at the Civil Service Commission Building, Burlington Gardens, W. 5 p.m. Prof. Nichol Smith, "Warton's History of English Poetry."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. E. C. Pound, "Pile Driving Formulas and Methods of Cast-in-Situ Concrete Piling, with special reference to the 'Vibro' Concrete Piling System."

Electrical Engineers, Institution of, at the Midland Institute, Birmingham. 7 p.m. Joint Meeting with Midland Centres of the Institutions of Civil and Mechanical Engineers.

United Service Institution, Whitehall, S.W. 3 p.m. Colonel D. C. Cameron, "The Problems of Supplying Mechanised Forces in the Field."

University of London, at King's College, Strand, W.C. 5.30 p.m. "The Social Background of English History." (Lecture VII). Mr. Bernard Rackham, "English Glass and Pottery."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture VII).

At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. J. Traill Stevenson, Demonstration of the Recordaphone.

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Dr. W. R. G. Atkins, "The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications." (Lecture III).

At University College, Gower Street, W.C. 3 p.m. Signor Camillo Pellizzi, "La Lirica del Paradiso." (Lecture VI).

5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist and Ryaberg." (Lecture I).

THURSDAY, FEBRUARY 28. . Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. R. A. Frazer, "The Flutter of Aeroplane Wings."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Carpenters, Worshipful Company of, Carpenters' Hall, Throgmorton Avenue, E.C. 8 p.m. Mr. E. Guy Dawber, "The English Countryside and Cottages—Old and New."

Electrical Engineers, Institution of, Savoy Place, W.C. Mr. Ll. B. Atkinson, "How Electricity Does Things." (Faraday Lecture).

Linnean Society, Burlington House, W. 5 p.m.

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Fred Skull, "Collecting Unusual Specimens of Old Furniture."

Mechanical Engineers, Institution of, at University College, Nottingham. 6.30 p.m. Mr. H. E. Yerbury, "Corrosion of Metals and its Prevention."

At the Engineers' Club, Manchester. 7.15 p.m. Mr. J. S. G. Primrose, "Micro-Examination of Failures."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Mr. W. A. Benton, "Metallurgy and the Evolution of the Balance."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. A. O. Rankine, "Physics in Relation to Oil Finding." (Lecture II).

University of London, at Bedford College for Women, Regents Park, N.W. 5.15 p.m. Mr. A. E. Henderson, "Byzantine Architecture."

At King's College, Strand, W.C. 5.30 p.m. "Czechoslovakia." (Lecture VII). Mr. Paul Selver, "Modern Currents in Literature."

(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Renaissance Poland." (Lecture VI).

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Ludford, "Cytology in Relation to Physiological Processes." (Lecture VI).

5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: A Course for Laymen." (Lecture II).

5.30 p.m. Prof. Dr. Edmund G. Gardner, "Lancelot and the Holy Grail."

FRIDAY, MARCH 1. . Chemical Industry, Society of, at Milton Hall, Manchester. 7.30 p.m. Dr. T. P. Hilditch, "Recent Advances in our Knowledge of the Structure of the more Common Fats."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Mr. W. Lawson, "The Rotor Bearings of Electricity Meters."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. (1) Mr. S. E. Hollingworth, "The Evolution of the Eden Drainage in the South and West." (2) Mr. M. Chatterjee, "The Accessory Minerals in the Bodmin Moor Granite."

Junior Engineers, Institution of, 39, Victoria Street, S.W. 7.30 p.m. Mr. L. S. Atkinson, "Notes on the Control of Electric Lifts."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Sir Joseph Isherwood, "Do the Rules of Classification Societies tend to Improve Shipbuilding and Engineering in this Country?"

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. Sir Israel Gollancz, "Problems in the Alliterative Poems."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Robert Robertson, "Infra-Red Spectra."

University of London, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture IV).

At King's College, Strand, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation."

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture VII).

5.30 p.m. Dr. J. Howard Jones, "Hygiene of the Mercantile Marine." (Lecture II).

SATURDAY, MARCH 2. . L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Prof. J. R. Ainsworth Davis, "English Food, Past and Present."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

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FRIDAY, MARCH 1st, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 4th, at 8 p.m. (Shaw Lecture.) SIR THOMAS MORRISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, "Thirty Years' Experience of Industrial Maladies (1898-1927)." (Lecture III.)

WEDNESDAY, MARCH 6th, at 8 p.m. (Ordinary Meeting.) TOM PURVIS, "Commercial Art." MR. PERCY V BRADSHAW will preside.

FRIDAY, MARCH 8th, at 4.30 p.m. (Indian Section.) W. H. MORELAND, C.S.I., C.I.E., formerly Director of Land Records and Agriculture, United Provinces, "The Indian Peasant in History. an Introduction to the Linlithgow Report." SIR EDWARD D MACLAGAN, K.C.S.I., K.C.I.E., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

SHAW LECTURES.

MONDAY, FEBRUARY 18th, 1929. SIR THOMAS MORRISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the first of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

TWELFTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 20th, 1929. PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., in the Chair.

A paper on "The History of the Development of Fast Dyeing and Dyes" was read by MR. JAMES MORTON, Chairman of Morton Sundour Fabrics, Ltd., and Scottish Dyes, Ltd. The paper and discussion will be published in the *Journal* on April 12th.

DOMINIONS AND COLONIES SECTION.

TUESDAY, FEBRUARY 26th, 1929. SIR WILLIAM J. LARKE, K.B.E., Director, National Federation of Iron and Steel Manufacturers, in the Chair.

A paper entitled "The South African Iron and Steel Industry: its Development and Possibilities" was read by DR. H. J. VAN DER BŸL, Chairman, South African Iron and Steel Corporation, Ltd.

The paper and discussion will be published in the *Journal* on April 19th.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

FRIDAY, DECEMBER 14TH, 1928.

DR. ARTHUR WILLIAM HILL, C.M.G., Sc.D., F.R.S., F.L.S., in the Chair.

THE CHAIRMAN said it was unnecessary to make any formal introduction of Lord Olivier, as his record of work in the Colonies of British Honduras, Jamaica, and in the Colonial Office, and the Ministry of Agriculture was so well known, and it would be agreed that he knew a good deal about the idiosyncrasies and mentality of agriculturists, both black and white. He had happened to look at "Who's Who," as Chairmen generally did, for some inspiration when taking the chair for a distinguished lecturer, and he noticed that Lord Olivier's recreations were put down as "the normal forms of loafing and dilettantism." He could not refrain from quoting that because this seemed to be very largely the attitude of the unsophisticated negro towards agriculture. If that were so, he felt that one of the reasons Lord Olivier was giving his paper that night was to show that there were ways and means of remedying that defect!

The following paper was then read:—

THE IMPROVEMENT OF NEGRO AGRICULTURE.

By the RIGHT HON. LORD OLIVIER, P.C., K.C.M.G., C.B., LL.D.

Agriculture is the paramount industry of our tropical and sub-tropical colonies. Englishmen are now attempting in Africa what they undertook in the 17th century in the West Indies, namely, as planters and farmers, to establish communities maintaining a European civilisation upon a basis of negro labour. In the West Indies the labour was that of kidnapped slaves. We now repudiate slavery and, theoretically and professedly, at any rate, forced or constrained labour. Can a stably prosperous agricultural State be built up by white men in a community where the labouring population are free native Africans? The history of Jamaica yields instructive material for guidance. Jamaica (population 920,000) is the largest agricultural community in the

British West Indies. Its civilisation is European, though of its inhabitants not one in sixty is white. Recent developments in West Africa are also, no doubt, significant. The prosperity of West African agriculture has advanced remarkably on much the same lines as those which have been found most advantageous among Jamaica negroes. And social improvements accompany the economic. But pioneers of white colonisation in East and South East Africa disclaim that West African developments can have any relevance to East African* problems, which are those of what is spoken of as a " white man's country," although the people to whom it looks for its manual labour are black. It might correspondingly be propounded that the economic and social history of Jamaica has also been so different from that of East Africa that no lessons can be learnt from the one by the other. I propose to attempt to indicate that in important essentials this is not the case, but that the conditions are impressively parallel.

European agriculture is a highly developed art, greatly superior in its total efficiency to that of African negroid communities. It is superior in its primary dealing with the soil, in regard to access, fencing, drainage and tillage, for which it is far better equipped with tools and machinery. It has evolved the art of manuring, both by combining cattle-keeping with tillage and by the application of chemistry. To its earlier machinery for ploughing, cleaning, drilling, harvesting, threshing, it has more recently added mechanical traction and transport. Most European tropical planting has involved the conjunction with husbandry of manufacturing processes, again requiring machinery and the developed techniques of Europe. Formerly every sugar estate was also a factory, progressively demanding improved engineering and chemistry. The same was true of coffee, tea, tobacco, fibres and other staples ; the marketable value of which depends upon factory processes, in almost all cases best carried on in large establishments, the capitalisation of which is impossible for peasant or native cultivators. There is now, indeed, a rapidly growing tendency to divorce manufacture from cultivation. The planters' work tends to specialise on pure farming, the manufacturing to be transferred to central factories, either independently capitalised or co-operatively owned and managed on behalf of the planters. An elaborate productive system of this character, which greatly increases the yield of agricultural values in proportion to the physical labour directly employed in the field, can only be introduced and established by representatives of the civilisation which has evolved modern methods of industry. Yet the actual work on the soil which grows the community's food and the raw materials destined for manufacture must, it is recognised, remain non-European. Can the labour of native Africans be made stably efficient in their share of this exotic and complex method of wealth production ? Englishmen are familiar with, and naturally have confidence in, our English system of capitalist farmers hiring and directing wage-labourers. They inevitably start by assuming that

* The best account, known to the writer, of East African Native Agriculture is the chapter by H. L. Shantz, of the U.S. Department of Agriculture, in the Report of the Phelps Stokes Trust Commission on African Education. Smith & Sons, 1924

an efficient agriculture must needs be so conducted, and that the establishment of such a system is the best thing European civilisation can offer the African, who will find it to his advantage to earn his living by regular work at wages. But that system has its roots in an agricultural, economic and social history which is peculiar to our own island. It does not predominate even so short a distance away as the other side of either channel that bounds our shores. It has no kind of root, preparation or parallel in uncivilised Africa, where no industrial revolution has created a landless working class; and it might appear at best somewhat sanguine to take it for granted that as a system of agriculture it is likely to prove the best in such a country, or even workable there.

African native agriculture, speaking generally, is precisely the same in its main characteristics as the agriculture of free negroes is in Jamaica or was until local missionaries and the Government began to pay attention to its improvement. The first operation of this characteristic African husbandry is to select uncleared land of suitable aspect and chance of rainfall, to cut down the trees and undergrowth and burn them upon the land. This process makes clearings generally averaging about an acre for each householder, rarely exceeding two. The soil of the forest is rich in humus-decayed leaf mould. The burning of the timber and brushwood provides a supply of potash, and destroys the insect life and weeds in the surface soil. The ground is broken up, roots are grubbed and burnt, and a garden of rich and fertile soil is provided. It is cultivated with the hoe, the cutlass or even more primitive tools, and food plants are sown and set. The East African Commission of 1924 referred in their Report rather regretfully to the "higgledy-piggledy" aspect of the native cultivation they saw. Of course, the cultivation is "higgledy-piggledy." It is made so on purpose. It is planted for a rotation. The expert cultivator sets each particular plant or kind of seed where he or she knows it will thrive best and fit in most conveniently with the general purpose. The selections and combinations are very varied. Of the vegetables and food plants and fruit trees cultivated in Africa and the West Indies some are indigenous; in both many of the commonest are exotic. There has been a remarkable diffusion of food plants between Asia, Africa and America. Yams of all sorts, sweet potatoes, gourds, beans and other legumes, spinach and salads, maize, millet, cassava, ground nuts, plantains, bananas, ochroes, akees, peppers, scallions, sugar-cane, coffee, tobacco, oranges, limes, these and other plants adapted to this kind of cultivation have been distributed in a profuse variety all round the world according to the character of the soils and climates. And traditional arts of growing them have been developed, whether the particular operations are discharged by women or men, or divided between them.

What the West Indian negro calls "bread-kind" (tubers producing starch foods), have to stand in some cases two years before they mature. Cassava stands three or longer. In between and round about the hills or ridges made for the tubers the quicker growing plants are put in and harvested successively

as they mature. Plantains and bananas may be set around the plot or here and there about it, so as not to shade the earlier crops too much. If the cultivator intends permanent occupation he will also plant coffee, kola, annatto or other shrubs to bring in food or money, when the vegetables have been reaped. But African agriculture of this type does not contemplate permanent occupation. Animal manure is not used, except by some more advanced African tribes.

This art of food cultivation is, for its purposes, highly efficient. On a well-chosen and well-handled plot the quantity of food produced is astonishing and the yield is continuous. In Jamaica especially, where the method has been intelligently developed and improved, good peasant cultivation of this mixed character yields annual values running frequently up to £40 an acre. But the method exhausts the land and the plot has to be shifted. A nomad habit is maintained in the population. Spent land must be abandoned to rest, as our own ancestors fallowed theirs before rotation husbandry was invented. But fallows in tropical countries cannot be pastured by cattle, because the acres are not continuous, and an open-field system cannot be practised, whilst weeds and coarse vegetation spring up more quickly than any sort of grass that will feed stock. When the yield no longer repays the labour the plot is allowed to grow up in bush. After a period of years the new jungle is again cut down and fired; the seeds of the weeds in the soil burnt up and the insect life destroyed. Cultivation is reinstated and proceeds as before. What the African husbandman likes best is virgin woodland. The accumulated fertility repays the heavy labour of clearing. The forest is ruined, to the grief of the lover of timber. After the land has been cleared once or more, it frequently happens that, by the time the cultivators has done with it, exposure to weather has caused a good deal of the soil to be washed away. This is one of the wasteful effects. The destruction of the forest diminishes the capacity of the soil to retain moisture and feed the springs; after repeated clearances the tropical rains wash out and carry away the humus, the soil becomes more and more barren, where it is shallow it is washed off bodily from the rock, or the hard raw subsoil is left exposed. Such "ruinate" land is a frequent eye-sore both in Africa and wherever the negro has practised this traditional husbandry. It is, in fact, a rational and efficient art of agriculture, so long as there is abundance of land to be used. To Europeans, who have so long had no land to waste, who have long ceased their migrations and have had to devise a system of static husbandry and renew their soil by manuring, native African agriculture is exasperating.

This traditional agriculture was imported into the West Indies by negro slaves, and so far as negroes either free or by sufferance had access there to land for their own purposes, this was the system they there pursued.

Jamaica in slavery-time had a well-developed system of arable and pastoral agriculture, carried on with an intelligence quite up to the standard of their times by English planters. In their generation they were as wise and as enterprising as new British settlers in Africa are in our own. Their sugar estates

lay in the plains around the shores of the island, or where suitable lands could be found in the valleys and uplands. They built and furnished fine homes and factories of good masonry suitable for their time, though too small for modern economy.

The coffee estates were among the mountains, very largely on the white limestone formation which covers three-fifths of the island. These planters also were able and spirited. Beckford's house at Fonthill in Jamaica has ruins as ambitious, proportionally, as those of his Wiltshire Folly.

Large areas of the island remained in forest. These lands were private property, but only used by their owners for timber and fuel supply for the sugar works. Most estates had their "mountain" for this purpose. In these "mountains" worn-out slaves, or freed negroes renting plots, were allowed to grow provisions. They practised their traditional African agriculture in methods indistinguishable from those used in West Africa to this day. This agriculture was not so highly developed as is that of some agricultural tribes in East and Central Africa. The West African and his West Indian descendant were not corn growers or field agriculturists. Nor had they cattle, and though Jamaica is so excellent a cattle country, cattle, whether for milk or manure, remained entirely unused by the negro squatters. Fortunately, most of the upland country has a porous chalky subsoil which retains moisture, and when land has been cleared for fuel or negro grounds, secondary forest and bush quickly reclothed it, which was not the case on the deeper and heavier soils.

Jamaica was settled with the intention that it should be a "white man's country." All the desirable land was granted out by the Crown in large "patents" of 2,000 acres or more to English settlers. Laborious Dutchmen were imported from Surinam to start sugar planting, as Africander farmers were introduced into Kenya. The lands were patented on a nominal quit rent of ½d. an acre. The unalienated lands, not of large extent, were remote and inaccessible. There was practically no land left for negroes to own, nor was there in early days any demand for it, for most of the negroes were slaves.

After emancipation the sugar and coffee estates declined. In the uplands many went out of hand entirely or were carried on with the least possible labour, as cattle, pimento, and logwood "pens." The negro quarters on the old sugar estates were miserable hovels. Their sites are marked to-day by the fruit trees that were planted about them; but the negro's favourite foodstuffs yams and other "bread kind," could not be grown there. They needed woodland soil and the African mode of culture. Some upland estates were bought by missionaries, chiefly Moravian. They built churches and schools and established villages of negro small-holders whom they helped in their agriculture and taught and encouraged to add to it, to grow coffee and other saleable crops and boil sugar for island markets. It was missionary effort of this kind that laid the foundations of improved negro peasant production and civilised life. On the estates which survived, the freed negroes remained very poor, very ill-

paid, very squalid and in no way progressive, at any rate so far as any influences of the estate system affected them. Partly, no doubt, owing to the traditions of slavery, estate work remained unimproving to them. Contact with it exercised no civilising or educational influence. The labourers were as lazy as they could be. No proprietor that could keep his estate going would sell land to negroes. The difficulty of obtaining plantation labour increased. In some of the smaller West Indian islands, where there was much unoccupied land, estates became more and more unworkable. The cultivation of sugar estates in Demerara, Trinidad and St. Lucia and parts of Jamaica was only maintained by importing indentured Indian labour. Some districts of Jamaica through special conditions managed to carry on without this, but the negroes there were poorest.

The Royal Commissioners who visited Jamaica in 1883 print a statement by the Rev. Josiah Cork, an Anglican clergyman, whose curacy began about the time of the abolition of slavery and who was one of those who endeavoured, by the provision of land and advice, to improve the conditions of the ex-slaves and free cultivators. He recalls that immediately after emancipation high rents were almost universally imposed by estate proprietors on the huts and provision grounds of the negroes upon their properties, and the wages of hired labour were reduced by one-half. The result was a hasty stampede from the estates of multitudes of labourers to purchase small freeholds, for which, when they were to be had, high prices were asked. On freeholds thus acquired, generally outlying (for the stronger estates would not sell) and with well-timbered lands, clearings were made for African agriculture, remote from the white men's estates.

It was to these out-lying lands that food growing was almost wholly transferred, for during the apprenticeship period which followed slavery the labourers had been for the most part confined to the land they had cultivated on the estates mountains, and had well-nigh exhausted it by 1838, when apprenticeship ceased. Only those, however, who had some command of means could acquire freeholds; the less provident, renting squatters or merely trespassers, had still to labour for hire and could only partially raise their food, or left food-growing to their families, while they worked for wages to earn money to buy land. Taxation was made heavy upon the small freeholders; the smaller the freehold, the higher the rate of the tax. The natural result was a growing discontent, which only the great fertility of the newly-occupied lands for a while partly stifled. (It will be observed that these conditions were essentially similar to those now regarded as necessary for the development of "white men's countries" in Africa, namely, restriction and segregation of negro landowning, the levying of high rents and high hut taxes, and pressure on the men to work on estates, leaving the burden of food-growing on the family). The apprenticeship system, which failed, had been designed philanthropically both to maintain the estates' cultivation and the civilisation of

the negroes by "contact." The resulting discontent rendered necessary some reform of the fiscal system and the burden of taxation was in some measure transferred from direct to indirect duties, of customs and excise, which, so far as food was concerned, did not press heavily on the negroes, who grew most of their own. And this, Mr. Cork remarks, must have happened years earlier had not the quantity of outlying woodlands been so great, a high rent being gladly paid for fresh food-growing lands, unaccompanied by the obnoxious direct property tax. As these lands became in many parts fully occupied, the natural result of wasteful culture ensued, the profit gradually came down to and fell below the rent. The fertility of the available lands being exhausted, the negro cultivators, left without guidance towards the improvement of their cultivation, so as to make continuous cropping possible, looked desperately towards the large reserved estates of the white landowners, and their increasing distress conduced largely to the Jamaica "Rebellion" of 1865.

This process is now repeating itself in South Africa in those parts in which white land monopoly has been established, and the improvement of native agriculture neglected. It will inevitably repeat itself in Rhodesia and Kenya, unless the policy of developing native agriculture and encouraging the production of crops that will yield the natives money is resolutely pursued. The essential superiority of estate cultivation and the European system of farming over the native African system of food-growing is that they are continuous, and put back into the soil year by year what they take out. Hence, unquestionably, in the West Indies, the sugar industry with its large productivity was of indispensable value, and so long as negro cultivation was left to take care of itself, the argument that the estates must be maintained, even at the cost of putting pressure upon the negroes to work on them, had some ostensible cogency.

> "The Commissioners," Mr. Cork wrote, "have only to examine for themselves to ascertain the fact that native food is far from being in abundance in the markets; the growers generally travel far from their homes to grow it and carry it far to sell it, the country the while being wholly deforested to meet the demand for food growth. This growth ought to suffice to make imported food in flour and other vegetables, and drinkables too, luxuries only, and to be bought as such by sale of the cultivator's surplus."

Forty to fifty years ago, then, the position in Jamaica was this. With a numerous and prolific population the larger sugar estates were being worked with imported labour; many properties were being maintained with a minimum of labour as "pens." Most of the island still was owned in large private estates thus handled, or in some cases rented to negroes cultivating in African fashion. In some districts where soil and climate were suitable and missionaries and education had done their work, there were many fairly prosperous and civilised "small settlers," intelligent black people of valuable character, growing coffee and other saleable produce, keeping ponies, mules, asses and some small

stock, but in other respects pursuing a system of agriculture still primitive and inefficient. There was a good deal of broken country from which the owners had disappeared and on which there were squatters living in wretched hovels and cultivating unprofitably and wastefully. The industry of the renters on estates which let land was of similar character. The cultivation of labourers resident on estates was superficial and worthless. There were some remote Crown lands still in thick forest, similarly squatted and trespassed upon. The Government was constantly being solicited to sell new lands to negroes outside the already partially settled districts. They were not unreasonably reluctant to do this, for "fire stick" cultivation had already destroyed much of the country, and operated to draw population further and further away from the centres of civilisation. Meanwhile the native food supply remained continually in danger of falling short.

After the "Jamaica Rebellion" Crown Government replaced the elected assembly which had represented the white landowning and planting oligarchy. The new legislature consisted at first entirely of officials and Government nominees. Nine elected members were introduced in 1883, the majority remaining official and nominated. In 1895 the elected membership was increased to fourteen, one for each parish. The elected members had the power to decide any question unless the Government declared its decision adversely to their vote to be of paramount public importance. The electoral qualification, for either men or women, is now occupancy as owner or tenant of house or land paying in local or island taxes not less than 10s. a year. The constitution has thus been progressively rendered almost completely democratic and the majority of the electors are peasant proprietors. The present Lord Irwin and Mr. Ormsby-Gore, who visited Jamaica in 1923, reported that this constitution has worked very healthily for the island, and recommended its still further liberalisation.

I recall this political history because it has done a good deal to influence the wholesome development of land policy and agricultural policy in the island during the last thirty years. Sir John Peter Grant, the first Crown Colony Governor, set up a "Survey of Lands" Department. All lands of which the ownership and title were not at that time apparent were progressively classified, their histories and titles inquired into and surveys made, and in cases where the lands were unclaimed or in illegal adverse possession, possession taken on behalf of the Crown. Many properties all over the island were in the occupancy of squatters, and on very extensive tracts the Crown quit rents had not been paid for years. Under successive laws the Government was made Trustee of all lands in the occupation of persons having no ostensible title.

If legal owners appeared they could recover the lands upon payment of the expenses incurred by the Government, and arrears of quit rent, but after seven

years notice the Government had the power to sell. Many thousands of acres were thus recovered from squatters. Much land has been restored to its legal owners, much has been sold after the expiry of the seven years' trusteeship, the remainder is still in the hands of the Government, some of it rented to tenants or exploited by the Crown Lands Department by licenses for timber and firewood.

Under the laws enabling the forfeit of lands for non-payment of quit rents the titles to more than a million acres have been investigated, the areas and boundaries ascertained and the lands advertised as forfeitable. Of this about 275,000 acres have been actually resumed by the Crown ; the quit rents on much of the rest have been paid, and much remains in process of forfeiture.

By this process of resumption of title to lands originally granted out in large estates with a view to "development," but left in neglect and withheld from legitimate use by the negroes, the Government was put in a position to deal with the land of the island in the interests of the whole community. The Governor who did most in this direction was the late Sir Henry Blake. Blake did two great things for Jamaica. Contrary to the prevailing view of the island's interests entertained by the planting community, he instituted an active policy of encouraging the creation of peasant properties on the recovered Crown Lands. And he founded the Royal Jamaica Agricultural Society.

His scheme for the sale of Crown land to small settlers was brought into operation in 1895. Not less than five acres nor more than fifty might be sold to any one person. The average price was £1 an acre. A deposit of one-fifth of the purchase money had to be made by the applicant, after which the land was surveyed and the applicant put in possession, the remaining four-fifths of the purchase money, together with £2 for the cost of survey, being payable in ten years by equal yearly instalments. If within ten years the purchaser had brought one-fifth into bearing in permanent crops, he was released from the payment of one-fifth of the purchase money or received a refund. The demand was immediate and has remained constant, and many thousands of small properties have been established by means of it.

The philosophy of improving agriculture through Government aid in tropical colonies has been progressive. In Jamaica it began, as it has done elsewhere, with the establishment of a Government Botanic Department, the principal purpose of which was to introduce, test, and naturalise exotic economic plants. It was only after the recommendations of the West Indian Royal Commission of 1927 that these institutions began to be broadened into Government Departments of Agriculture. That Commission's report resulted in the establishment of the Imperial West Indian Department of Agriculture, and the latest important offspring of the same stimulus is the Imperial College of Tropical Agriculture in Trinidad. The Department of Public Gardens and Plantations in Jamaica, founded by Sir J. P. Grant, had attempted the cultivation of cinchona and tea, and under Sir Henry Blake established groves of oranges and grape-fruit experimentally in the Blue Mountains. These direct undertakings failed, but

the Department had liberally and usefully distributed seeds and seedlings of economic plants and trees. Its operations were still essentially based on the aim of helping white planters with estate cultivation. The Jamaica Agricultural Department which grew out of it progressively enlarged its scope and activities, establishing a scientific staff, including chemists, entomologists and microbiologists, to which there have been latterly added inspectors of plant diseases. This Government Department also maintains successfully two stock farms and an agricultural school. The Jamaica Government first began to pay some attention to negro production by appointing a travelling instructor attached to the Public Gardens. But his visits, which were intended to give advice in the pruning and curing of cocoa, coffee and other exportable produce, were regarded by the peasantry with suspicion. They judged that they were really made for the purpose of spying out any prosperity they might attain to, with a view to increasing their taxes. The prodigious increase of banana growing, which was built up on peasant production, being an African crop, then completely despised by the planters, but which had, in fact, been the means of saving the island from such disastrous depression as resulted elsewhere from the collapse of the sugar industry, had greatly increased their prosperity, and peasant property and small settler's agriculture were looking up and becoming recognised as of public value. But there was a tax on cultivated land as distinct from waste land, and, trivial as its incidence was, it maintained a preference for a method of husbandry that could not be identified as cultivation. The problem of improving negro agriculture was never really tackled until the Jamaica Agricultural Society, ostensibly detached from the Government, was established.

The Society was founded, almost simultaneously with the Crown Lands Settlement Scheme, in 1895. The Legislature granted £1,000 towards its expenses of organisation. Special Committees were appointed to investigate the position of each agricultural industry, what could be done to improve the quality of agricultural produce, whether its variety could be increased and new industries developed, the markets available, and whether better means of handling and shipping products could be suggested. Full reports were made on these subjects. The establishment of a Government Stock farm was recommended. It opened its public work on much the same lines as those followed by the great Agricultural Societies in this country, holding large and expensively organised shows either for the whole of the island or for the principal convenient divisions; and the favoured exhibits were cattle and horse-kind and representative products of the large estate cultivation. But the purposes of the Society and the aims of those who most devotedly worked for it were much further-reaching. They were addressed to transforming the African agriculture of the peasantry into an intelligent and scientific system of profitable production. For this purpose it was vital to get into touch with the "small settlers," the backbone of the negro population, who were actually at the time (owing to the development of the banana trade) producing the bulk of the exports. It was

essential to get these people to understand the Society's aims, to show them what it was doing, what it proposed to do, and what it could do with the co-operation of the community, and generally to try and arouse an earnest interest in and enthusiasm for improved agriculture. But these men deeply suspected the Government, associating it (as African natives have even more reason to do to-day) principally with the imposition and collection of taxes. This gulf had to be bridged. The Board of Management being mainly elected to represent all agricultural classes, and free to criticise the Government, to press agricultural needs and reforms upon its attention, to inquire sympathetically into the grievances and needs of small settlers and to make due representations if these were found reasonable, was an institution well constituted to mitigate this suspicious aloofness. This missionary enterprise involved protracted and energetic effort on the part of the leaders of the Society, its successive Secretaries and their staff. Their work encountered obstinate conservatism, indifference, easy-going insouciance and self-confident ignorance in both the principal agricultural classes, and at best a good-humoured tolerance, grumbles that the Society was a waste of public money and a confident belief that the effort would soon collapse.

In 1897, however, the Legislature was induced to increase its grant to £4,000, and the Society began to publish a monthly journal, which has appeared ever since without intermission; except when the printing office collapsed in the earthquake of 1907.

The establishment of local Branch Societies had been intended, but did not at first make much progress. One travelling instructor was employed, detached from the Department of Public Gardens and Plantations, and an instructor in bee-keeping. The Society took steps to promote and extend the manufacture of Jippa-Jappa (Jamaica Panama) hats, a strictly local industry, by distributing the fibre plant in suitable districts and by holding classes.

The Branch Societies slowly grew; they began to invite the presence of the travelling instructor at their Meetings and for visits to members' holdings. Two, and then three, part-time instructors were added. More and more instructors to be assigned to particular districts had to be found, and worked on full time. The Secretary of the Society, who visited each district regularly, was the link between the Instructors and the Managing Board.

The Journal became popular, articles in it were read and discussed at meetings. Reports at Branch meetings began to appear in the newspapers. Correspondence with the Central Office increased steadily.

	Direct Members	Branches	Branch Members	Agricultural Instructors
In 1897 there were ...	364	6 with	300	1
,, 1910 ,, ,, ...	500	63 ,,	3,300	11
,, 1923 ,, ,, ...	571	267 ,,	7,621	16

The work of the instructors is the Society's most influential function. They attend all Meetings of Branches, report to the office the attendance and the subjects discussed, give addresses on technical topics of current importance and generally deal with local agricultural matters. They take interest in the work of Agricultural Loan Banks and help to establish them. They are not allowed to act on Bank Committees, but give advice and help where these have not able local assistance already. Nearly all the Local Loan Banks have been established through the Branch Societies, but are run as distinct bodies. The work of the Instructors is governed by the Society's Instructors' Committee which meets every month. Each Instructor submits a proposed itinerary of his work for each day in full detail of time and place, so that the travelling Supervisor of Instructors may be able to appear there without special notice, and go through the work of the day or the week with him. Each month the Instructors send in a detailed report of their work and a general report on the cultural interests of their district and the state of the crops. These reports are submitted to the Instructors' Committee with analyses and remarks by the Secretary.

The instructors in the course of their work give constant demonstrations on the people's own grounds on pruning and spraying, advice on the suppression of insect pests and treatment of plant diseases and on suitable methods of cultivation generally. They carry out many local experiments for the improvement of holdings in connection with local prize competitions. They are constantly on the watch to detect diseases and insect pests. Any symptoms of the most important diseases are immediately reported to the Secretary and to the Director of Agriculture, whose inspectors are despatched to attend to them.

During the earlier years of this work the general public did not see very striking results—they had to be looked for on the peasants' own lands—but a great development was going on quietly. The value of the organisation and work was extremely appreciable after the hurricane of 1903 and again during the great drought of 1907 and even more after the hurricane of 1912, when seeds and plants were quickly and systematically distributed through the Branch Societies and admirable restorative work done by the agricultural instructors by holding-to-holding visits. The scope of the Society and the numbers of its branches were on each of these occasions quickly extended. The hurricane of 1912 gave an impetus to the formation of Loan Banks. After that of 1903 the Government had begun to make direct loans to the peasantry to reinstate their permanent crops. The demand for the formation of branches and for the appointment of instructors outran the funds available. Branch Societies increasingly sent representatives to the General Meeting; until it was decided that the business required two half-yearly General Meetings; and recently there has been a demand for a two-days' meeting half-yearly.

The instructors are very carefully chosen after tests of their qualifications both in the field and by written examination and receive some business training

in the Society's office. There is plenty of competition for these posts, largely among the class of men who would make successful schoolmasters, loving agriculture and good friends with their people. Considerable versatility, knowledge and tact are required. They have shown themselves a very public-spirited body of men and on special emergencies caused by hurricanes or outbreaks of plant disease have worked most valuably.

The Branch Societies are debarred from political discussion or action, but proposals affecting the public administration of agricultural interests are discussed and debated locally, examined and criticised at the Board, and approved representations made to the Government or the Director of Agriculture.

Experience has shown that one of the most effectual means for increasing effort and production among the small cultivators is competition for prizes for holdings. Competitions are held in rotation in groups of four parishes in yearly succession, and timely preparations for them are made with the help and advice of local instructors. Marks are given on a classified scheme of purposes to be aimed at: the house, the garden, fencing, stock, poultry, provision-ground cultivation, drainage and water storage, coffee and other permanent cash-yielding crops, manuring, mulching, tillage, the pruning and care of fruit trees. These competitions have proved so popular and so convincing in results that in addition to the regular scheme, small local food-growing competitions, principally for yams, corn, and cassava, have been organised by Branches subscribing their own prize money, with occasional help from neighbouring proprietors. During the War the Society's organisation enabled great special efforts in food-growing drives to be organised. In the yam-growing competitions it is required that plantains, bananas, coffee and orange trees be planted through the yams, thus securing the establishment of permanent crops. These competitions are always carried out on old lands, some of them previously almost derelict, and the effects of cultivation, manure, and bush mulching in securing good crops from such lands, and through periods of protracted drought, have been remarkable. The established example spreads to the non-competitors.

Agricultural Shows, always popular and attractive, are now organised by the Branches themselves. The Society supplies tents on hire, receptacles for exhibits and instructors to judge and help in arrangements. The Secretary attends all Shows. In addition to live stock and riding and driving competitions all manner of agricultural produce is entered, local handicraft of all sorts, women's home industries, hat weaving, laundry and needlework.

The Society and the island owe much to public-spirited men of all clasess who have continuously taken a leading part in its work, and especially to the peculiar qualifications and unflagging energy and enthusiasm of its two successive Secretaries. The democratic character of its organisation and the contact which it has established between the planting and pen-keeping class

whose members act on the Board and in many Branches, and the peasant agriculture for the improvement of which they have heartily worked, have been most valuable to the social atmosphere of the island. In regard to control of plant diseases and the maintenance of the quality of the island's stables, the interests of the two classes are plainly identical. Moreover, in Jamaica, more and more, there is ceasing to be the former line of distinction between the two main classes of cultivators, for out of the small settlers' agriculture there has arisen a gradation of planting enterprises of all dimensions between the normal £40 holding of the small settler, and the 2,000 acre estate of the planter or pen-keeper.

There are now in Jamaica 151,000 taxed holdings of land exceeding ¼ acre. Of these about 115,000 are of £40 value or less, 22,000 between £40 and £100, 13,000 more, not exceeding £1,000, and 1,400 exceeding £1,000.

There is much parallelism between the Jamaica conditions and policy in regard to land and labour which I have reviewed, and those now in play in East Africa, where immigrants are setting up a community dependent chiefly on agriculture, with a white employing class and negro labourers. In both it is axiomatic that the organised cultural art and practice of Europeans are necessary for the maintenance of the essentials of white civilisation. In both there is a populace of African cultivators, dependent for their food supply upon an incomplete agriculture carried on in an unstable and in some respects wasteful fashion. Although the condition of the peasantry of Jamaica has been much modified and improved, the progress has been from a condition of things which two generations ago appeared to many people quite as unpromising, notwithstanding previous centuries of white civilisation, as they may appear in Kenya to-day. For purposes of comparison I speak of Kenya especially, because the ambition of European settlement there is to make it a community of a character as different from West Africa as are the British West Indies. Elsewhere in Africa there is being attempted a policy of building up a civilisation based on the native life. There was never any notion of that in the West Indies, and it is not the policy in Kenya to-day: at any rate, so far as concerns that portion of the extensive area so-called, which forms the highland enclave deemed suitable for permanent white habitation. Jamaica, it might appear, had advantages which made negro progress there easier. It had: but the significant thing is that they had accomplished so little. The institutions of State were English in character: the language was English: Christianity was diffused elementary school education, though long withheld, and still very deficient was widely available. The estates had for generations been worked on a system of agriculture founded on European practice, well adapted to local conditions. Negroes had been trained for generations upon these estates The black population was plentiful. The maintenance of estate cultivation was regarded as the first necessity of the State. The acquisition and occupation of land by negroes had been discouraged and restricted as much as possible

not only on the plea of economic advantage but on the argument that work on estates and contact with the employing class was an educative influence and that the negroes became barbarised (which was true) if they got away into the backwoods far from markets, churches and schools. The fiscal system had been trimmed to subserve this policy; never, indeed, with such frank directness as it is in our new African Colonies, because British sentiment with regard to dealings with negroes still at that period remained liberal, and paid respect to the principles which had decreed the abolition of slavery. Nevertheless, as now in Africa, the taxes on the negroes' huts were excessive, the taxes on their holdings were burdensome out of all proportion to those on larger properties. Heavy import duties were levied upon such merchandise as they were likely to wish to buy, in order to encourage them to work for more money to buy them. Notwithstanding this pressure and the abundance of population, the planters suffered from lack of labour supply and clamoured for Indian immigrants, while outside the estates there persisted and slowly extended the African system of agriculture. Some proprietors abandoned their cultivation and rented land to squatters. Others allowed grounds rent-free to tenants who would give them labour as wages. The complaint was not so much that the labour was inefficient as that it was intermittent and unreliable. Except in such an island as Barbados, where there is complete white land monopoly, this must generally be the case in a mixed community: for the normal man, whether black or white, prefers to be his own master and to use his own time and industry as it suits him best. The estates' wages were very low--9d. and 1/- a day—and if the negro had had to depend upon them for buying his food, he must have starved. The food supply for the most part necessarily depended upon the peasant agriculture. The negro householder had perforce to devote part of his time to his food cultivation. Growing crops for sale as well he had to attend to these in their season and to harvest and market them. His bananas he had to cut and carry down to the wharf on the same days as his banana-growing employer. The existence of a negro system of agriculture must needs cause uncertainty of labour supply to a concurrent European estate system. This is recognised in Kenya to-day, and sufficient taxation has been imposed on the natives there to induce them to make labour contracts of periods from one to six months. This no Jamaica negro would ever do, regarding it as a renewal of slavery. These contracts can only be enforced in Africa by rigorous masters' and servants' laws, for the application of which, by the aid of the police, a system of registration and thumb-print indentification of labourers has been imposed on the natives of Kenya, greatly to their dissatisfaction. The feeling of the negro about such contracts, whether in the West Indies or in East Africa, is simple and logical. He says: "I am willing to sell you my labour when, although the wages are small, it is worth my while to take them, for so long as I want to earn them. If after I have worked three days I stop my work, you stop my wages: we are neither of us the worse:

we have made a fair exchange." The notion of binding himself to continue to sell his work after he has ceased to want the wages, appears to him ridiculous, and except under pressure he will not do it. And he resents the pressure. Obviously, however, that kind of labour supply makes systematic farming impossible.

The renting of land to squatters and the employment of labour tenants on an estate have always been found in the long run undesirable. South African native policy is increasingly set on getting rid of squatter tenure, either by assigning land for purchase by natives or, if the more liberal ideas are followed, by encouraging permanent leasehold tenure. The temporary labour tenant proves equally unsatisfactory. His holding not being his own, he will not build a substantial house: he will not establish permanent cultivation of saleable produce: he exhausts one garden plot and shifts to another. Leaving his wife in her village at home, he takes a new consort on the estate and disseminates bastardy or disease. Either the squatter or labour tenant cannot keep stock or, if he does so, they invariably become a nuisance to the estate proprietor. He and his household become a nest of thieves. They steal from the estates, and, having themselves no interest in permanent cultivation, they steal from one another and from their neighbours who have.

The Government of Jamaica began its attempts to improve the African peasant agriculture of the island by direct methods: setting up demonstration plots, sending Kew-trained gardeners to lecture, distributing pamphlets. Such measures were as ineffectual as the like have been when attempted by the Board of Agriculture in this country for the improvement of British farming. The contempt of the negro planter for all this kind of "buckra foolishness" was hardly less complete than is that of the British farmer for Whitehall agriculture. It is a mistake to suppose that British-trained agriculturists can see at a glance what is wrong and what is right with African methods, the product of long traditional experience. Instructors had to be found who did not appear as officers of the State or agents of the employing class, but were men who understood and sympathised with the lives of the people and loved to work with them. They proceeded experimentally, not on Government demonstration plots, which to the negroes meant nothing, but by inducing them on their own grounds to try methods of improving things good and useful for themselves. They improved tillage by substituting the digging fork for the hoe, and showing how to use it.

The report of the Supervisor of Instructors on holdings entered for competition in the parish of Manchester for 1927-28 bears witness to the results attained in the development of the art of negro agriculture without shifting of ground:—

"This is the seventh Prize Holdings Competition held in this Parish since the inauguration of this very valuable work by the Jamaica Agricultural Society

and while some of the former competitions have been carried through under difficulties, there has never been anything to compare with the present instance. Heavy and continuous rains prevailed throughout September and October, then suddenly ceased: from November, 1927 to July, 1928, hot sun and hot dry winds persisted day after day, until the earth became parched, and the usual agricultural operations became impossible, and the water supply for both man and beast was practically exhausted, making it necessary to spend much valuable time in going from district to district in search of water. However, in spite of these great difficulties the competitors persisted in their efforts to protect their crops and stock against the effects of the drought, and to get the holdings ready for the competition

"While, of course, the holdings could not fail to show the ill-effects of the long drought, they certainly showed still more prominently the good effects of care and cultivation. To see the way in which some of the competitors have brought their crops through a drought of nearly ten months' duration was gratifying beyond measure. As I have already mentioned, the task of judging these holdings was not made more pleasant by the hot, dry winds and scorching sun, but at the same time they did but render the contrast afforded by the beautifully cultivated citrus and coffee groves more refreshing. While the majority of people in the parish were getting desperately short of water it was most pleasing to see some competitors who could point with pride to stores of beautifully clear fresh water, and there is no doubt that the peasantry generally are making great improvements in the provision of this first essential of life, thanks to the help available from the parochial funds at the instigation of the Jamaica Agricultural Society. Great improvements are also observable in the housing and general surroundings of the competitors. Thirty-eight were awarded full marks for the condition of their house, and the sanitary conditions also show a very marked improvement, and it is only fair to mention here that the Jamaica Agricultural Society was the first body to methodically urge improvement on these lines. The general condition of the stock throughout the whole competition showed most marked improvement, I do not think I saw one tick.

"Manchester, together with some of the other parishes and sections of parishes, was noted even from the early days of the competition for the very neat and tidy holdings, and in some instances the well-kept staple crops, particularly coffee, pimento and citrus But beyond a certain point there was a kind of stagnation, a want of life, energy and interest and the lack of a desire for further development, and particularly any decided or systematic effort to combat the effect of drought and other climatic difficulties. After following with keen interest the influence of these competitions, and the detailed work of the instructors over a long number of years, and comparing the conditions that exist to-day with the past, say, 15 or 20 years ago, one is greatly impressed with the changes which have been brought about. The holdings of the present day which have come under the above influence are full of life and interest, and are alert to receive advice and suggestions for development of all kinds. The keeping of stock on the holdings has vastly increased and the use that is now made of these for maintaining the fertility of the soil has made great changes. The introduction of heavy "bush" mulching has made possible the growing of splendid crops of yams and other foodstuffs, as well as excellent bananas for export on land which in the past would have been considered impossible. The introduction of improved methods of cultivation, the knowledge of how

to treat pests and diseases, and how to fight the evil effects of a drought, etc., have created a new interest and given a wider outlook on life, and it is impossible at the present time to go into an up-to-date holding without feeling the change. The manner in which so many of the holdings have come through the recent prolonged and severe drought should be an eloquent testimony to the value of these changes."

I feel no doubt whatever that similar methods can be applied to native African agriculture with much of the same results as have been obtained in Jamaica. It is a slow process, but it progresses and does not go back. It is thirty years since it was taken in hand in Jamaica and it might appear to a visitor, who did not know what the conditions were before, that nothing very magnificent has been done. But the work done is truly substantial and the younger generation will profit by it more rapidly.

One great help in Jamaica has been that the banana, like coffee, became a money crop common to both estates and small-holders. Bananas were long solely a negro's crop. The estates ignored it. Its arable cultivation was first methodically taken up by an American schooner captain and later by a Scotch Government Medical Officer on abandoned sugar estates. Its tillage, drainage, manuring, pruning, etc., were developed by such innovators and the improved methods have reacted on the peasants' cultivation. In connection with such crops of his own the negro cultivator is ready to profit by the methods of Europeans, and those of his class who go out to work on estates know their work when they come to it and practise it as an art, as they will not practise agricultural tasks which they have mechanically discharged as operations for their employer's profit. A growing population of negro peasant proprietors continually produces young men who want work as estate labourers. The more the agriculture which is indispensable to the mass of the people and which cannot be superseded by large estate work is improved and developed, the better becomes the service available, at fair rates of wages, from the labourers who seek work, and the better their understanding of the needs of estate employers and of the fairness of their demand for continuous and reliable service.

DISCUSSION.

THE CHAIRMAN said the address had been a very interesting and able one, all the more so because the lecturer could speak with such first-hand knowledge on the subject. It was interesting to mark the point made by the African Commission about negro agricultural methods being higgledy-piggledy. When he himself went to West Africa some years ago the same thing struck him on looking at things rather superficially, but then looking into the matter more deeply he realised that, after all, the West African negro, like the West Indian, had been carrying on that form of agricultural work for 2,000 years or more, and it was the business of scientific people not to condemn off-hand what was being done as higgledy-piggledy and as being all wrong; nor was it wise to try to make the natives adopt European methods which might be quite unsuitable for the country;

it was rather the business of those interested to try and discover what were the underlying principles of what the negro was doing in his agricultural work and what was suitable to the conditions of the country, and to help the negro to improve them. He was hopeful that now the new Colonial Office scholars were taking up their agricultural appointments throughout the Tropics they would go out, after their training in Trinidad, with their eyes open as to the possibilities of native methods of cultivation. He hoped that by carefully studying Native methods they would learn a great deal which would help to build up a proper science of tropical agriculture in directions where it was so very much needed. One point worth referring to with regard to the natives of West Africa and the West Indies, in contrast to those in East Africa, was that there was a difference in the habits of the two peoples. The West Africans and West Indians were fruit-eating people, and the East African grain-eating, and that had a great deal to do with their different habits of life, and he thought made some of the problems in East Africa rather more difficult than perhaps they had been in West Africa and Jamaica. There were one or two members of the audience present who knew a good deal about negro work, and he should be glad if they would join in the discussion.

MR. W. MCGREGOR ROSS said with regard to the growth of native agriculture in the West Indies, he should like to ask whether it was the case that the native cultivators were liable to interruption in their agricultural pursuits by any form of *corvée* or compulsory unpaid service.

LORD OLIVIER said that there was nothing of that kind in the West Indies. In British Honduras there were customary village services.

MR. HAROLD POOLEY, Director, British Empire Producers' Organisation, desired to add one word to what the lecturer had said in regard to the Jamaica Agricultural Society, as he had had some opportunity, when he visited the West Indies last year on behalf of the British Empire Producers' Organisation, of seeing its work on the spot, and also of comparing its activities with similar bodies in other parts of the Empire, and he should like very strongly to endorse everything the lecturer had said in his paper. The Jamaica Agricultural Society was doing unique work, and it might very well be taken as the model for similar activities in other parts of the Empire. One feature appealed to him particularly and that was the extraordinary way in which the instructors hid their efficiency. If there was anything which would do no good at all, but would do a great deal of harm, it was hustle, because immediately a man started to hustle a native he ceased to be in any way effective. The instructors went around and did all their work with a sort of happy-go-lucky air, but at their meetings, when they got together and discussed what they had done and their programme for the next month, there was a very different atmosphere. He thought the *ars celare artem* was a very important factor in the work of that particular body. He should like to have the views of the lecturer on the possibility of co-operation for marketing amongst African and other negro producers. The problem was an important one at the present moment and the efficiency of production went hand in hand with it, but production was more easy to deal with than marketing and he should like to hear views on the subject from anyone who could give him information as to attempts at co-operation amongst negro small producers and the possibilities of such co-operation in the future.

MR. W. F. HUTCHISON said he had listened with great interest to the paper because he knew the lecturer's record and that he was a friend of the Africans. He himself was an African farmer. He was a native of the Gold Coast and had been engaged for fifteen years planting and farming amongst farmers to many of whom he was bound by the ties of friendship and relationship, and the result of his investigations and work inspired great respect for the African farmer. The African's practice was sound, and he had been very pleased to see that the agricultural officers, the superintendents of agriculture, had been driven to admit that on the whole the native African system of farming had produced excellent results, and a European instructor must make very sure of his ground before he undertook to teach the African on the subject. Great progress was being made in West Africa, especially on the Gold Coast, where attempts were being made amongst them in every way to organise their agriculture. An effort was being made at co-operation in Lagos, where farmers were uniting themselves in a Farmers' Society for the purpose of marketing their products. He asked all those who wished to see African agriculture improved to be very patient, because peasant agriculture was not merely an occupation, but a manner of life, and when the African was asked to change his system of agriculture he was being asked to go through half-a-dozen revolutions, moral and social. In the first place, a change from African to European methods was a change from communism to individualism, which in itself was an enormous revolution. In addition to that, the whole of African life was permeated with religion, and when one changed the African's life and his methods of life it was really asking him to change his religion with all the moral dangers which accompanied the destruction of one religion before there was another religion to take its place.

MR. JOHN SUMMERSCALES thought it was known that natives all over tropical Africa were trying to specialise too much on one crop. In the Gambia almost the entire native population was engaged in the production of ground-nuts. In Uganda cotton counted for 90 per cent. of the total export trade. These specialised money crops were no doubt desirable when the demand was great. But when the demand was low, as in the case of the bumper American cotton crop of 1925, widespread distress was apt to be caused.

MR. ROBERT S. REID said he had listened to the lecture with the greatest possible pleasure, as it almost recited his own history and training as a planter. As a business man he went out to Trinidad forty years ago for the benefit of his health and bought some land in an absolutely derelict little island, Tobago. What the lecturer had said was almost the history of his experience there. The people were at that stage when they had lost the art of working. Thanks to sugar bounties the sugar industry was wiped out, there being only one or two making sugar with windmills. He bought the estate for a song, 5s. per acre freehold, and the vendors were glad to get that because he was the only one that offered anything at all. When he first went to the island it was impossible even to change a sovereign; the people would not change even a five-dollar note because they said they only wished for silver and the note was of no use to them. That was just the history of his education as a planter in Tobago. The people would only plant sugar on a system which the lecturer must know. There was no money to pay wages, and a man who had a plant divided his land amongst his workers, five or ten acres a-piece, and supplied them with the canes which they planted. When the crop season came round the owner of the estate supplied carts and the men cut down the canes and brought

them in and made sugar. After it was made the proprietor received one-half of the sugar and one-half of the molasses and the other half was the wages of the growers. That was a primitive stage of barter. Barter was pretty frequent there, even the parson being paid in chickens, eggs, vegetables, etc. That was only thirty or forty years ago. His own men wanted him to grow sugar, but he said he would grow cocoa instead. The method he adopted was his own idea, and had been followed by much greater men. He arranged to grow a small quantity of cocoa himself; the men were most unwilling, but he doubled their wages and they were perfectly satisfied, though nobody in the place would work more than two days a week. After two years he gave them land to plant cocoa according to the methods the lecturer had explained. In between the cocoa trees they grew foodstuffs. Tobago now was not only covered with big cocoa estates, but had 6,000 proprietors owning from 1 to 1,500 acres. He believed the right method was to encourage the people to develop individuality. The progress in that little island, material, educational and moral, was something remarkable. Those in the West Indies would like more union between all the islands as it would benefit everybody. There were headquarters in the Tropical College for research and it would be possible to get mutual help in their agricultural development

DR. J. M. DALZIEL said that during his years in West Africa he had heard it stated as a gibe that an African farmer with a crop to which he was accustomed could produce better results than his advisers from the Agricultural Department, and in certain instances within limits that would be true. If so, the reason might be related to the fact that the study of soils had only recently been seriously undertaken. It appeared that the result so far as it went was to show that in West Africa almost all soils had a high acidity. As is well known, iron oxide was very widely distributed in that country and the majority of soils there could be classed under laterite in some degree or other. People there began to appreciate that the African, far from being indolent by nature, really deserved to be rehabilitated in reputation having regard to the handicap under which he worked. The improvement of the soil was of paramount importance, whether it was done by manuring or by artificial fertilisers, or by proper rotation of crops, but outside the evergreen forest the most hopeful remedy for the soil was fertilising by stock. Wherever there was grass there was a considerable probability of rearing cattle, especially if the tsetse fly could be abolished. In French Guinea they had gone a stage further and the ox was being increasingly used as a draught animal with the plough and harrow, and one important result was that it was no longer necessary to import rice into French Guinea; in fact, there was now an export of rice. In the words of the Governor of that Colony, only increased energy put into the ground could bring about an increased production, and it was impossible to obtain that excess of energy from the human machine alone. For soils of low fertility the best accessory labour was oxen. In French Guinea ox-ploughed land had proved so much more fertile than when tickled by the hoe that very many families assisted by agricultural credit aimed at possessing ploughs and various other agricultural implements. There were now in French Guinea about 3-4000 ploughs. The natural manure which was obtained produced very good results, and with increased crops there came the idea of individual ownership instead of communal owning. On the Ivory Coast a farmer could get individual ownership although it was contrary to local custom. That was not a principle to be imitated, but he thought it might be suggested that elsewhere in West Africa the rising generation were deciding for themselves that the future of native agriculture would be developed on the line

of small-holdings. They had already got beyond the stage where they cultivated only what was required for the family need, plus the amount needed for the assessment of the native chief. With a money currency crops were having a money value. It seemed almost inevitable that at a time when the family system was being subject to disintegrating influences from many causes the tendency would be for the economic crop to be exploited by individuals of greater initiative, and it was for the agricultural officers to encourage such ambition and to guide it in the direction of improved quality and yield, and at the same time to educate gradually the natives to extend cultivation and to plant along with foodstuffs permanent crops, coffee, cocoa, kola, cotton or bananas, according to the locality.

LORD OLIVIER, in reply, said he had listened with great pleasure to the contributions made to the discussion and was especially delighted with what Mr. Pooley had said about the Jamaica Agricultural Society being a unique institution. He did not think any Society had done so much work of that particular kind elsewhere in the world. Mr. Pooley had laid his finger upon an idiosyncrasy of the Society, that it had laid itself out to select the proper kind of instructor. To teach an African it was necessary to be humble and aware of one's own ignorance. It was not simply a matter of discovering by scientific methods in the Trinidad Agricultural College what was necessary for cultivation, and then trying to show that to the African, because it was not in his bones to learn in that abrupt manner. It was necessary to go to him and first of all realise that any such comment as " Agriculture is higgledy-piggledy " was beside the question ; it was necessary to recognise at the beginning that to one coming out from England the first impression native agriculture would be certainly an ignorant one, and then it was necessary to learn what was the truth about it, and that could only be done by going amongst the people themselves. He had learned to appreciate negro agriculture and how it should be dealt with by the men who were able to do it. One of these was Mr. Palache, who came from a French family of Haiti, and was a breeder of race horses, was interested in agriculture and found his true vocation in it, and he was a great friend of all the Creoles. He was an extraordinarily sympathetic and understanding man with the negroes, talking their particular patois. Another friend of his was Mr. Walter Jekyll, a devotee of gardening, who lived amongst the mountains in Jamaica and was thoroughly intimate with the negroes and spoke of how the negroes had shown him why they planted a thing here or there and so on—they had a fund of indigenous art. It was necessary to start with what the negro knew and then make suggestions to help him. In Jamaica there were sixteen thoroughly capable instructors. Mr. Arnett was a senior instructor, and what he said about the enormous improvement of negro cultivation might be thoroughly relied upon.

They had got over loafing and dilettantism and a real work was being done, a work which he did not think was being done anywhere else. Another matter was the question of co-operation. Many years ago Mr. Demercado was intensely interested in this question. Being a merchant he was anxious to obtain uniform grades of coffee properly cured, and the Agricultural Society and himself tried to found small co-operative societies to which the natives could bring their berries before they were cured. That method had been one of great difficulty in Jamaica and very little progress had been made. The Jamaica smallholder, as a rule, and still more his wife, had a great idea of marketing and driving a bargain; they went to the market with their little sample and went from buyer to buyer and would not mix up their samples with anybody else's. It was difficult to get them to believe that, if they put in a certain quantity of berries, when the

division came about they would get their fair share. The Jamaica Society had always desired to establish co-operative production and curing, but with very little result. Some success had been achieved in introducing some measure of co-operation through loan banks, and there was now a fairly vigorous institution of co-operative loan banks in Jamaica, which had to be established not by argument but by practical methods. A hurricane occurred in 1903 and it was found necessary, in order to enable the small producers of bananas to re-establish their cultivation, to make them loans, and loans to the amount of nearly £30,000 were made in order to get a banana crop on the ground again. The loans were repaid but he (the speaker) had made it a condition that those who took loans must put their property on the register of title. On the next occasion, when a hurricane occurred, he again said loans would be made and the negroes then knowing their value were keen to have them. There was a great demand for loans and the security was good. He told them he would only make loans if they would make a local co-operative loan bank and take up shares progressively year by year. A practical scheme was developed and the Agricultural Loan Bank had now established a number of branches which were working fairly well. That was the only way of dealing with the African, whom Nature and man had conspired to make an extremely cautious person, or he would not have survived at all. It had been said that there was a great risk in depending on one crop—like the ground nut, for instance—and that was perfectly true. The population of Jamaica depended largely on bananas, which dependence was bad, but it was worse to have the whole population of an island or a country depending on an estate crop like sugar. The negro not only grew bananas and coffee for export, but also grew his own food. It was a dangerous thing to wean an African population from the habit of growing their own food and make them dependent on export crops. It was important to maintain the custom of growing food supplies and help to make the food supply efficient, and then staples might be grown for export. Great Britain had gone a long way from growing its own food and was dependent on trade, but Africa was a long distance from that. The growing of food by the negro was negro agriculture, and that was the work that they were trying to improve in Jamaica. In Uganda a great deal of labour had been diverted from food production to cotton growing. The Government became afraid that there might be a famine and had to take special means to insist on land being put into cultivation again for foodstuffs. He had been very much interested in what Mr. Hutchison said in contributing to the elucidation of the subject, and also in the remarks made by Dr. Dalziel. On the very intractable soil in West Africa it was greatly to the credit of the African people that they had found a system of food cultivation which enabled them to maintain themselves upon it. That was *primâ facie* evidence that African cultivation was not so foolish as it might appear to Europeans. West African negroes were not cattle people and did not know much about cows, although they were in Jamaica fond of horses and good at breeding mules and donkeys. They did not drink milk. The Jamaica Society had largely increased the keeping of small stock. Cows and pigs had to be tethered out. It had been possible to utilise the manure, thereby rendering it unnecessary to continue to change the ground. The negroes had come to understand what could be done in Jamaica. Unquestionably the improvement of negro agriculture must imply that the family plot must remain stable, with a fixity of tenure. Even in the African tribal system particular grounds remained in families, and in South Africa they had definitely attempted to encroach upon the communal systems by giving the land under particular conditions to persons who would cultivate it, and a leasehold title was given to people as long as they cultivated. The effect of building up a system of stable agriculture necessarily implied a fixity of tenure because the manure had to be

kept going continuously. It meant the cessation of the habit of wandering cultivation and an extension of individual property.

A hearty vote of thanks having been accorded to the lecturer, the meeting terminated.

OBITUARY.

THOMAS HOLMES BLAKESLEY, M.A., M Inst.C.E.—Mr. T. H. Blakesley, who died at his London home on February 13th, at the age of 81, had been a member of the Society for exactly fifty years, having joined as a Life Fellow in 1879. Born in 1847, he was the second son of the Very Rev. J W. Blakesley, Dean of Lincoln, and was educated at Charterhouse and King's College, Cambridge, where he graduated as a Wrangler in 1869. Soon after leaving Cambridge he accepted an appointment under the Ceylon Government as an irrigation engineer, and during his residence in Ceylon made a study of the ruins of Sigiri, of which he contributed an account to the Royal Asiatic Society in 1875, and also discovered the existence of a large mass of meteoric iron by the local effect on the magnetic declination. His real bent was in the direction of physical science, and in this field he is to be credited with a number of important researches. He improved the methods of defining and measuring the properties of optical instruments, and invented new forms of lenses and spectroscopes. His work in electricity included researches on alternating currents and allied problems connected with telegraph cables and electrical power transmission. In 1885 he was appointed instructor in physics and mathematics at the Royal Naval College, Greenwich, and this fortunate appointment, which he owed to Professor W. D. Niven, F.R.S., provided him with the necessary facilities for carrying out experimental and research work. Blakesley's studies on the subject of alternating currents were first published in the *Electrician*, and his famous work entitled "Papers on Alternating Currents for the use of Students and Engineers" appeared in 1885. The book ran into four editions and was also published in Germany, France and Russia.

Important as were his contributions to the solution of electrical problems, Blakesley himself regarded the reform of the teaching of geometrical optics to have been the main achievement of his life. In 1897 he read a paper before the Physical Society, in which he explained the principles of his proposed reforms, and published a more complete account in his book entitled "Geometrical Optics," which appeared in 1903. He also contributed to the same Society a description of a new barometer, called the "Amphisbaena," and an important paper on "Logarithmic Lattice-works." His synthetic spectroscope which superimposes three homogeneous portions of the spectrum upon each other, is a beautiful instrument, an example of which was presented by the Mercers' Company, of which Blakesley was Master in 1902 and 1903, to the Finsbury Technical College.

Blakesley remained at the Royal Naval College until 1904, and even in recent years continued his studies in optics and lattice-works, though owing to failing health he was unable to put them into shape for publication. For a number of years he was honorary secretary of the Physical Society, where his happy and kindly disposition was a potent influence in promoting good relations between scientific and industrial physicists.

GENERAL NOTES.

COMPETITION FOR THE DESIGN OF A SIGN TO DENOTE PETROL FILLING STATIONS AND GARAGES.—A great step forward in the preservation of the amenities of roads throughout the country has now been made possible. Powers have been granted by Parliament to County Councils and Borough Councils to make by-laws for regulating the appearance of petrol stations. It is hoped that something better than the untidy filling stations that are so often to be seen will be the result. In this connection the Home Secretary has appointed a Committee to consider among other things the question of the exhibition of advertisements on petrol filling stations. The Royal Institute of British Architects have been asked to arrange for a competition among architects and other artists for a design for a national sign that will denote filling stations, and a sum of £100 has been allocated for the purpose of providing prizes. Particulars and conditions of the competition can be obtained on application to the Secretary, The Royal Institute of British Architects, 9, Conduit Street, W.1.

TRAVELLING SCHOLARSHIPS IN SANITARY SCIENCE AND MUNICIPAL ENGINEERING.—The Chadwick Trustees invite applications for two travelling scholarships of £400 a year each, tenable for one year, to be awarded next July; one scholarship to be in Sanitary Science and the other in Municipal Engineering. The object of the scholarships is to enable the holders to travel abroad to study, either generally or in some particular aspect, the methods adopted in different countries for the prevention of disease and the improvement of public health, or the sanitary administration and engineering applied in urban or rural areas. Candidates must be British subjects, between 25 and 30 years of age, who have graduated in a British University or who can produce evidence of attainments or of intellectual equipment proving them to be capable of methodical study and research. A candidate, prior to appointment, must submit for the approval of the Trustees a scheme of study which he would be prepared to undertake and the itinerary he would propose to follow. Applications should be made by letter before March 25th, 1929, to the Clerk of the Chadwick Trustees at 204, Abbey House, Westminster, S.W.1, stating name, qualifications, age, and proposed object of study or research, accompanied by copies of testimonials and evidence of previous work undertaken or published.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. RADIO RESEARCH. SPECIAL REPORT NO. 6.—AN INVESTIGATION OF A ROTATING RADIO BEACON.—This report describes experiments carried out on a radio beacon transmitter, the aerial system of which consists of a rotating loop or frame coil. After an initial calibration of the beacon a series of tests was carried out in various ships under actual sea-going conditions, in order to establish the reliability of this system of radio direction finding as an aid to marine navigation. In these tests the accuracy of the wireless bearings obtained from the beacon was measured at various distances, and the range of the beacon for reliable working was ascertained. The night errors which were encountered at the longer distances were studied in more detail at various fixed positions chosen to show the effect of transmission over sea and land respectively. In the latter part of the investigation a direct comparison was made both at sea and on land between the bearings observed on the rotating beacon and those obtainable with a direction finder used in the ordinary manner.

As a result of such experiments it is shown in the report that the rotating loop beacon can give reliable bearings of the same order of accuracy and at similar ranges as those obtainable with other systems of wireless direction finding under the most favourable conditions. A great advantage possessed by the rotating beacon system is that it requires only an ordinary wireless receiver and a suitable watch to enable a ship to take bearings, and that the method overcomes certain disadvantages met with when using direction finders on board ship, particularly in the case of small ships. It is, therefore, likely that this system will prove of considerable value in the application of wireless to marine navigation. The report, which contains six illustrations in the text and seven plates, can be obtained, price 2*s.* 3*d.* (postage extra) from H.M. Stationery Office, Adastral House, Kingsway, W.C.2, or through any bookseller.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.—ENGINEERING RESEARCH. SPECIAL REPORT NO. 3. THE CAUSES OF FAILURE OF WROUGHT IRON CHAINS.—Many cases have been encountered in practice in which wrought iron chains have failed under circumstances where such factors as gross overloading or defective material could be excluded. The present report describes an investigation which has been conducted at the National Physical Laboratory with the object of determining the conditions under which wrought iron chains become liable to sudden failure in a manner usually associated with brittle materials. The desirability of periodical annealing as a restorative treatment has also been investigated. Experiments on chains taken from service of known history, together with a large number of laboratory experiments, have shown that the main cause of deterioration in service of wrought iron chains is the production on the links of a hardened skin by repeated small impacts. These impacts are received in the movement of link on link, hammering on the ground, rattling through hawse pipes and similar actions. The existence of this thin brittle skin renders the chain link extremely liable to sudden failure under quite small stresses. The application of bending forces, particularly those due to shock, produces in the hardened skin a crack of such a shape that great stress concentrations occur at its root, and consequently the crack passes on through the entire section of the link with the absorption of very little energy. Annealing at a dull red heat causes recrystallisation and softening of the hardened skin, thus restoring the link to its normal ductile state. Normalising from 1,000° C. produces the same result. The relative merits of annealing and normalising are fully discussed. The Report, a Royal octavo volume containing 107 pages and 91 illustrations, may be obtained, price 7s. 6d. net (postage extra), from H.M. Stationery Office, Adastral House, Kingsway, W.C.2, or through any bookseller.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 4..Aeronautical Society, at the Institution of Electrical Engineers, Savoy Place, W.C. 6.30 p.m. Group-Captain H. M. Cave-Browne-Cave, "Royal Air Force Far-East Flight."

Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Dr. Leonard Hill, "Modern Methods of Heating and Ventilation."

Chemical Industry, Society of, at Burlington House, W. 8 p.m. 1. Prof. A. R. Ling, "Recent Advances in the Chemistry of Polysaccharides and Allied Compounds." 2. Dr. F. W. Norris, "Recent Researches of Pectous Substances."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Variable-Speed Alternating-Current Motors," opened by Mr. L. J. Hunt.

At the University, Edmund Street, Birmingham. 7 p.m Discussion on "The Anticipation of Demand and the Economic Selection, Provision and Layout of Plant," with introductory papers by Capt. J. M. Donaldson (Power Systems) and Mr. J. G. Hines (Telephone Systems).

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. H. R. Lordly, "The Waterproofing of Concrete Structures."

Farmers' Club, at the Whitehall Rooms, Northumberland Avenue, S.W. 4 p.m. Sir John Russell, "Farming in Australasia: its Bearing on British Farming."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mrs. Gordon-Gallien, Mr. J. W. Cornwall and Mr. Colin C. Rose, "The Kalambo Falls, Northern Rhodesia."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Mr. P. L. Thompson, "Recent Developments in Town Planning."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. A. R. Short, "Recent Literature concerning the Origin of Species."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture II.)

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Paul Vacher, "Present Aspects of French Politics." (Lecture III.)

At University College, Gower Street, W.C. 2 p.m. Prof. Dr. A. W. Reed, "Victorian England."

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture IV.)

At University College Hospital Medical School, Gower Street, W.C. 5.30 p.m. Dr. A. Maitland Ramsay, "The Eye in General Medicine." (Lecture I.)

TUESDAY, MARCH 5.. Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Mr. A. E. L. Chorlton, "The Heavy Oil Engine on Road and Rail."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Conrad Gribble, "Impact in Railway Bridges, with particular reference to the Report of the Bridge Stress Committee."

Electrical Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Messrs. E. B. Wedmore, W. B. Whitney and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking."

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m.

Industrial Transport Association, at Australia House, Strand, W.C. 6.30 p.m. Mr. John H. Stirk, "Canadian and American Travel and Transport."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Prof. J. S. Huxley, "Evolution and the Problem of Species." (Lecture VI.)

United Service Institution, Whitehall, S.W. 3.30 p.m. Anniversary Meeting.

University of London, at the Institution of Electrical Engideers, Savoy Place, Victoria Embankment, W.C. 5.30 p.m. Mr. Luigi Emanueli, "High Tension Cables." (Lecture V.)

At King's College, Strand, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture VIII.)

5.30 p.m. Mr. C. B. Unwin, "The Application of Direct Current Motors to Heavy Traction." (Lecture IV.)

At University College, Gower Street, W.C. 5.30 p.m. Lecture on "The Current Work of the Biometric and Eugenics Laboratories." (Lecture VI.)

Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, MARCH 6.. Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Mr. A. L. Andrew, "The Cryoscopic Method for the Detection of Added Water in Milk. (2) Christine M. Fear, "The Alkaloid Test for Tannin."

Geological Society, Burlington House, W. 5.30 p.m. Mrs. M. M. Ogilvie Gordon, D.Sc., "The Structure of the Western Dolomites."

Heating and Ventilating Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Dr. B. J. Owen, "The Dessication of Vegetable Material."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Roman Studies, Society for the Promotion of, at Burlington House, W. 4.30 p.m. Lecture by Mr. R. P. Longden.

United Service Institution, Whitehall, S.W. 3 p.m. Captain J. V. Creagh, "The Fleet of the Future."

University of London, at King's College, Strand, W.C. 5 p.m. The Rt. Hon. Sir Frederick Pollock, "Judicial Caution and Valour."

5.30 p.m. "The Social Background of English History." (Lecture VIII.)—Sir Charles Allom, "English Woodwork and Furniture."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture VIII).

At the London School of Economics, Houghton Street, W.C. 6 p.m. Capt. V. W. Garwood, "Coin-counting Machines."

At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist, and Rydberg." (Lecture II.)

At University College Hospital Medical School, Gower Street, W.C. 5.30 p.m. Dr. A. Maitland Ramsay, "The Eye in General Medicine." (Lecture II.)

THURSDAY, MARCH 7.. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. C. N. H. Lock, "Airscrew Body Interference."

Chemical Society, Burlington House, W. 8 p.m. 1. Mr. F. G. Mann, "The Stability of Complex Metallic Salts." 2. Mr. A. B. Manning, "The Determination of Unsaturated and Aromatic Hydrocarbons in Light Oils and Motor Spirits." 3. Mr. S. Glasstone, "Studies of Electrolytic Polarisation. Part VII. Complex Cyanides. (*a*) Silver." 4. Mr. S. Glasstone, "Studies of Electrolytic Polarisation. Part VIII. Complex Cyanides. (*b*) Copper."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Mr. E. S. Ritter, "Picture Telegraphy."

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Sydney J. Davies, "Some of London's Heirlooms of Industry."

Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. J. G. Weir, "Modern Feed-Water Circuits."

At the Engineers' Club, Manchester. 7.15 p.m. Mr. A. B. Winterbottom, "Heat Insulation."

Oil and Colour Chemists' Association, at the Painters' Hall, Little Trinity Lane, E.C. 7.30 p.m. Continuation of Discussion of "The Painting of Cement and Plaster." (Joint Meeting with Incorporated Institute of British Decorators.)

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Use of Language and its Difficulties."

Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-upon-Tyne. 7.30 p.m. Mr. E. McClelland, "Some Aspects of Selling Rail Travel."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture IV.)

5.30 p.m. M. Marcu Beza, "Byzantine Influences on Roumanian Literature." (Lecture I.)

5.30 p.m. "Czechoslovakia." (Lecture VIII.)—Mr. J. Hanc, "Modern Currents in Czechoslovak Art and Culture."

(King's College.) At 40, Torrington Square, W.C. 5.30 p.m. Mr. N. B. Jopson, "The Early Civilisation of the Slavs." (Lecture I.)

At University College, Gower Street, W.C. 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture I.)

5.15 p.m. Prof. J. E. G. de Montmorency, "The Principles of Law: a Course for Laymen." (Lecture III.)

5.30 p.m. Signor A. M. Bassani, "Nicolo Tommaseo" (in Italian).

FRIDAY, MARCH 8.. Astronomical Society, Burlington House, W. 5 p.m.

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Metals, Institute of, at the University, St. George's Square, Sheffield. 7.30 p.m. Messrs. D. F. Campbell and W. S. Gifford, "Progress of Electric Furnaces."

Oil and Colour Chemists' Association, at Milton Hall, Manchester. 7.30 p.m. Mr. S. T. Kinsman, "A few Notes on the Fastness to Light of Lake Colours."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1. Dr. Ezer Griffiths, and Mr. J. H. Awbery, "The Dependence of the Mobility of Ions in Air on the Relative Humidity." 2. Prof. A. M. Tyndall, "Some unsolved Problems relating to the Mobility of Gaseous Ions." General Discussion on the Mobility of ions.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. T. F. Tout, "The Place of Women in Later Medieval Civilization."

University of London (King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture III.)

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology."

5.30 p.m. Dr. J. Howard [illegible] the [illegible]

[illegible] Eye in General Medicine. (Lecture III.)

SATURDAY, MARCH 9.. L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. R. W. Sloley, "The Cave-Artists of the Stone Age."

[illegible] Street, W. 3 p.m. [illegible] Ernest [illegible] Motions in Rarefied [illegible]

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3981. VOL. LXXVII.

FRIDAY, MARCH 8th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 13th, at 8 p.m. (Ordinary Meeting.) R. P. G. DENMAN, A.M.I.E.E. (of the Science Museum, South Kensington), "Loud Speakers." DR. WILLIAM HENRY ECCLES, D.Sc., F.R.S., will preside.

SHAW LECTURES.

MONDAY, FEBRUARY 25th, 1929. SIR THOMAS MORISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the second of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

THE PRESERVATION OF ANCIENT COTTAGES.

A general meeting, at which THE RIGHT HON. J. RAMSAY MACDONALD, M.P., presided, of subscribers to the Fund for the Preservation of Ancient Cottages was held on Wednesday, February 27th. A resolution that the report of progress up to 31st December, 1928, which had been previously circulated, should be adopted, was proposed by the Chairman, and supported by Mr. G. K. CHESTERTON, SIR CHARLES WAKEFIELD, Bt., C.B.E., MR. H. AVRAY TIPPING, F.S.A., and LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O. At the conclusion of the meeting a vote of thanks to the Chairman was proposed by SIR GEORGE SUTTON, Bt., Chairman of the Council, and carried unanimously.

A full report of the meeting will be published in the *Journal* at an early date.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 27th, 1929. DR. L. A. JORDAN, D.Sc., A.R.C.S., in the Chair.

A paper on "East Indian Copals and Damars" was read by MR. A. F. SUTER. The paper and discussion will be published in the *Journal* dated April 26th.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 13TH, 1929.

MR. H. V. TAYLOR, A.R.C.S., B.Sc., O.B.E., Commissioner of Horticulture, Ministry of Agriculture and Fisheries, in the Chair.

The following Paper was read:—

THE STUDY OF THE ORDER OF FLOWERING AND POLLINATION OF FRUIT BLOSSOMS APPLIED TO COMMERCIAL FRUIT GROWING.

By CECIL H. HOOPER, F.L.S., M.R.A.C., F.S.I., OF WYE, KENT.

The object of this paper is to show that observations of fruit blossoms and their insect visitors may be used as a guide in orchard planting and in the increase of the crop of fruit.

It is granted that many things are necessary in order to secure a good and profitable fruit crop; one naturally thinks of the need for healthy trees, efficient drainage, suitable soil, proper cultivation, freedom or protection from diseases and insect pests, kindly weather especially at blossoming time, and, lastly, a remunerative market.

Botany, however, teaches us that the pollination of fruit is well worth careful and thoughtful study as without fertilisation fruit is not produced.

By pollination is meant the transference of pollen grains from the anthers to the stigmas; the pollen grain there germinates, throwing out a pollen tube which travels through the style to fertilise the ovule, which then becomes a seed and around which the fleshy fruit forms.

Agricultural and horticultural research has devoted much of its energy to explaining why many good practices which have been long in existence are right (liming, for example). Our forefathers planted orchards of mixed varieties, whether it was of apples or cherries, and kept bees; recent research on fruit pollination has proved that both were good practices.

The Arabs, certainly as far back as the time of Mahomet, cut pollen-bearing branches from the male date palms, carried them up the fruit-bearing trees

and tied them among the branches for the wind to distribute the pollen. The Turks must have long known that without a certain little wasp they could not get a crop of Smyrna figs. Probably neither the Arab nor the Turk would satisfy the botany examiner of London University as to his knowledge of fruit pollination, but observation and experience have taught each a great deal, and it has been left for recent years to explain the facts in botanical terms.

In growing our common English fruits we get examples of wind and insect pollination; self and cross fertilization.

Wind Pollination.

Cob and filbert nuts and walnuts each produce dust like pollen which is carried by the wind to the female flowers; in each of these botanical observation has something to teach. To ensure a crop it is necessary that the pollen be shed at the time that the stigmas of the little nut flowers are receptive. The catkin-bearing branches must not be pruned off before the nut flowers are fertilised; some varieties do not bear many catkins, and in some kinds the time of pollen shedding and of the nut flower blossom do not syncronize, so that it may be advantageous to have a few trees of another variety to assist the pollination. The late Mr. George Bunyard recommended planting an occasional Cosford Cob through the nut plantation, it being a variety that bears many catkins. Professor E. J. Wickson, of California University, has shown that for growing walnuts commercially it is advisable to inter-plant several varieties, as in some sorts the pollen is shed too early or too late for the female flowers on the same tree. In the garden of an uncle at Sheldwich, Kent, there were two walnut trees standing about ten yards apart; one was a soft-shelled walnut, the other a hard-shelled walnut; he kept an account of the yield, and in 30 years the trees bore 340 bushels of nuts, which sold for £69 8s. (besides some kept for the house). I believe the good and regular yield was due to the fact that they were different varieties and cross-pollinated one another efficiently.

Insect Pollinated Fruits.

The *strawberry* is pollinated both by wind and insects. *Raspberries* and *Loganberries* are perfectly self-fruitful, *i.e.*, they mature fruit perfectly with pollen of the same plant, but they need insects to carry the pollen. If insects are excluded from the blossoms, the fruit is imperfect and deformed. Hive bees are very fond of raspberries, and undoubtedly increase the crop, and the raspberry is one of the best plants for honey production.

Gooseberries, *red currants* and *black currants* all mature fruit perfectly with pollen of the same plant, but their pollen is glutinous, like minute grains of boiled sago, which clings together and cannot be transported by the wind, so they are dependent on insects to carry it from the anthers to the stigmas.

Where a large acreage of gooseberries or black currants is grown, there may not be sufficient wild insects to visit the blossoms, and growers find that by placing hives of bees in the plantations they get more fruit.

FRUIT TREES.

In fruit trees profuse blossoming does not necessarily foretell a large crop; weak trees sometimes flower excessively to the disadvantage of maturing fruit; super-abundance of flowers apparently wastes energy.

In the case of apples, cherries, pears and plums it is found that the blossoms are practically entirely dependent on insects for fertilization; experiments show that wind carries very little of the pollen from flower to flower. In these fruits a new factor comes in, *viz.*, that a large number of the varieties will not mature fruit when pollinated by pollen of the same variety. A new variety is originated as a seedling and is propagated by budding and grafting on other stocks; consequently, the pollen is similar whether it comes from the same flower, the same tree, or another tree of the same variety, though it may be growing at a distance.

Self-fertile or *self-fruitful* is a term applied to a variety that matures a considerable proportion of its blossoms into fruit with pollen of the same variety.

Partially self-fruitful means that only a small proportion of the flowers will mature fruit with pollen of the same variety.

Self-sterile is a term applied to varieties that will mature no fruit with their own pollen, or mature only perhaps one fruit in a thousand blossoms, which is for practical purposes self-sterile; there are varieties, such as Cox's Orange Pippin, and Lane's Prince Albert, which in many trials have shown themselves to be self-sterile, although one flower out of 2,000 may eventually mature a fruit under glass after several years of trial.

Of apples grown in the open about two-thirds of the varieties appear to be self-sterile, and no variety is sufficiently self-fruitful to plant profitably in a block alone.

About half the varieties of pears are somewhat self-fruitful, but they are relatively less self-fruitful than apples.

With plums, about half are more or less self-fruitful and half are self-sterile, or nearly so.

Among cherries, Morello is perfectly self-fertile, Flemish and Kentish preserving cherries and May Duke are to a small extent self-fertile, but the sweet cherry varieties are all either absolutely self-sterile, or self-fruitful to the extent of only one or two per cent. It is consequently not surprising that there are cherry orchards which year by year crop badly, especially as some varieties of cherry are inter-sterile, *i.e.*, will not mature fruit with pollen of the other variety.

As cross-pollination is shown to be beneficial in increasing the crop, it is

necessary to ascertain that the varieties which it is proposed to plant together flower at about the same time ; one should avoid planting early flowering with late flowering, unless there is a mid-season flowering variety which will pollinate both.

It may be stated that, provided the two varieties are in flower at the same time, the pollen of one variety is as good in the production of fruit as is another : in the U.S.A. in experiments with apples some varieties are found to cross-pollinate better than others ; personally, I believe there is a difference (especially in some of the shyer bearing varieties) and that a variety may bear more fruit with one kind of pollen than with that of another. I think this may be more the case with fruit grown in the open than that grown in the more comfortable glass house.

It is interesting to find that different varieties of the various fruits flower in a definite order in the same way as the flowers of the countryside, where the snowdrop is followed by the aconite, the crocus by the hazel, lesser celandine by the coltsfoot, almond by wood anemone, and so forth ; in like manner the different varieties of pear, plum, apple and cherry flower in fairly regular succession. In former days orchards were planted with a large number of varieties which mutually cross-pollinated one another, but in wishing to lessen the number of varieties and in order to grow a large quantity of a remunerative variety, some orchards have been planted with one variety only, or with two varieties that do not flower at the same time or, in the case of some cherry orchards, with varieties that do not cross-pollinate.

Careful records of the order of flowering of apples, pears and plums have been kept at six or eight observation stations in Australia for several years and these records correspond fairly nearly with those kept in England ; thus Black Diamond plum flowers early and Pond's Seedling late ; in pears, Brockworth Park flowers the earliest with Keiffer's Hybrid, whilst Williams's Bon Chrêtien, Marie Louise, Glou Morceau and Beurré Capiaumont flower late, showing that the order of blossoming in Australia closely resembles that in England. In Australia many more English varieties of apples, pears, plums and cherries are grown than in Canada and the U.S.A.; one wonders why European varieties of apples should thrive better in Australia than they do in America; very few American varieties of apple succeed in England.

PEARS.

Pears are of special interest in the history of research in fruit pollination, as it was in 1890 that Mr. M. B. Waite was asked by the Department of Agriculture of the U.S.A. to investigate the cause of unfruitfulness of an orchard of 22,000 Williams's Bon Chrêtien trees which, although planted fifteen years and healthy, hardly yielded any fruit. In this orchard it happened that three trees of different varieties had been planted by mistake among the Williams (two Clapp's Favourite and one Buffam). In the neighbourhood of these three trees the

Williams were very productive, bearing down the branches to the ground with the weight of the fruit. His previous experiments led Mr. Waite to believe that this limited and local abundance was caused by cross-fertilisation from the other trees, and this view was fully confirmed by all his subsequent experiments. I had an example of the importance of pollination in pear, though on a very small scale, when fruit farming at Swanley, Kent; I planted 48 Pitmaston Duchess trees in an apple orchard on flat land rather low; although for four years they flowered well, they did not mature a single fruit. I therefore had them taken up and replanted them on a hill side about a quarter of a mile away in a plantation of pears of different sorts and placed a hive of bees amongst them; the trees then bore well.

In my own experiments I have found the following varieties more or less self-fruitful:—Conference, Dr. Jules Guyot, Chalk, Beurré d'Amanlis, Swan's Egg, Colmar d'été, Duchesse d'Augoulême, Marguerite Marillat, Winter Windsor, Jargonelle, Souvenir du Congrès, Beurré Jean van Geert, Beurré Diel, Durondeau, Petite Marguerite, Blickling and Glou Morceau. Only one fruit from each has matured with me out of many trials with Pitmaston, Williams and Doyenne du Comice. No fruit matured in my trials with own pollen from Clapp's Favourite, Fertility, Emile d'Heyst or Catillac.

At the Royal Horticultural Society's Gardens, at Wisley, Mr. Chittenden and Mr. Rawes have experimented to a considerable extent on the pollination of pears as well as of apples and plums; in a recent letter Mr. Chittenden gave me the names of fifty-two varieties that had been found to be self-fertile to a greater or lesser extent under glass, and of forty-four that had not so far matured fruit with pollen of the same variety.

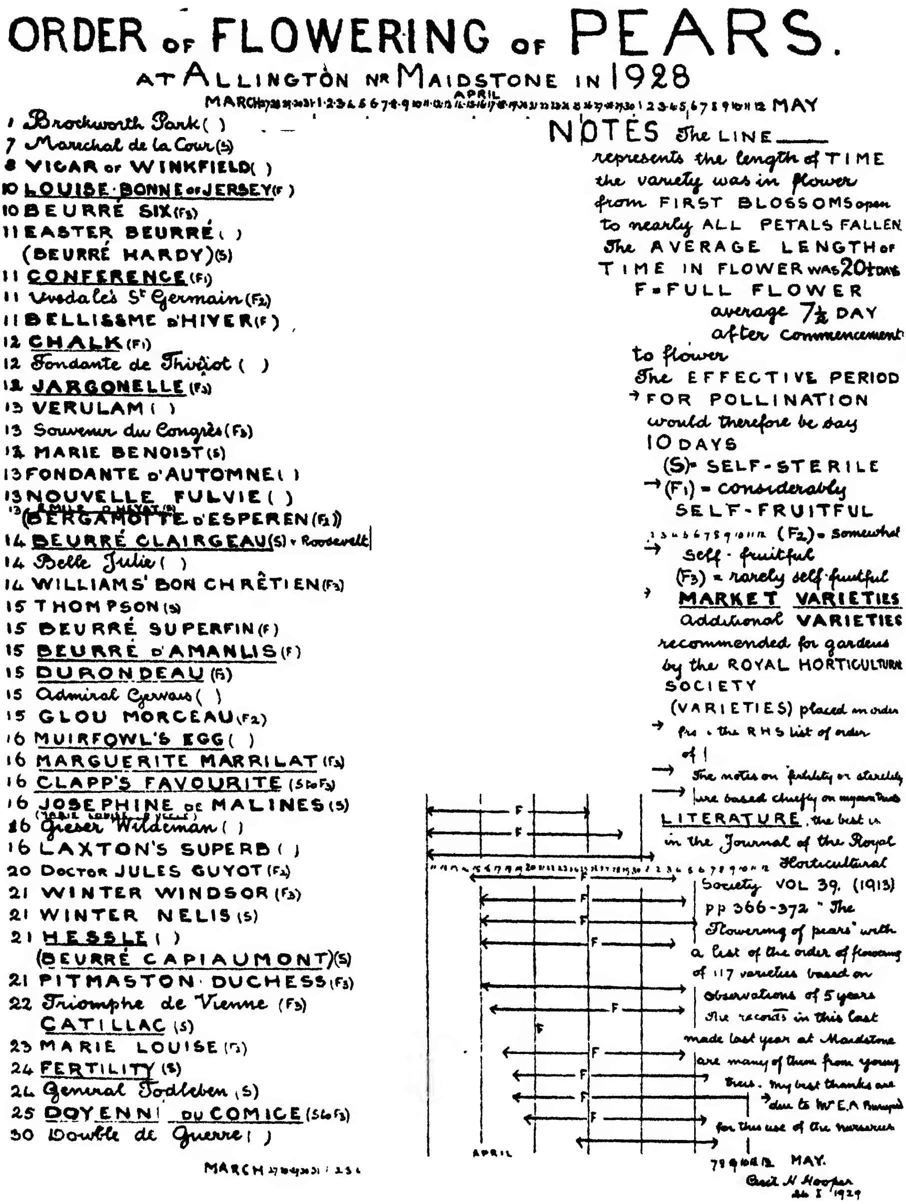
In pears some of the best varieties are shy bearers. Last year I tried twenty-six different kinds of pollen with Doyenne du Comice but only from six of these did fruit mature; these were from pollen of Hessle, Triomphe de Vienne, Fertility, Gregoire Bourdillon and Madame Lye Baltet; but another year many of the other varieties which failed might mature good fruit.

Careful observations in successful and unsuccessful pear plantations might yield many facts and suggestions which might be checked by pollination trials.

Among successful pollination results were:—Clapp's Favourite with Conference; Dr. Jules Guyot with Clapp's Favourite, Roosevelt; Fertility with Conference; Durondeau with Fertility; General Todleben with Conference; Vicar of Winkfield with Winter Cresanne; Williams's Bon Chrêtien with Clapp's Favourite, Winter Cresanne or Fertility; Pitmaston with Conference or Williams's Bon Chrêtien; Uvedale's St. Germain with Marie Louise; Catillac with Fertility or Uvedale's St. Germain.

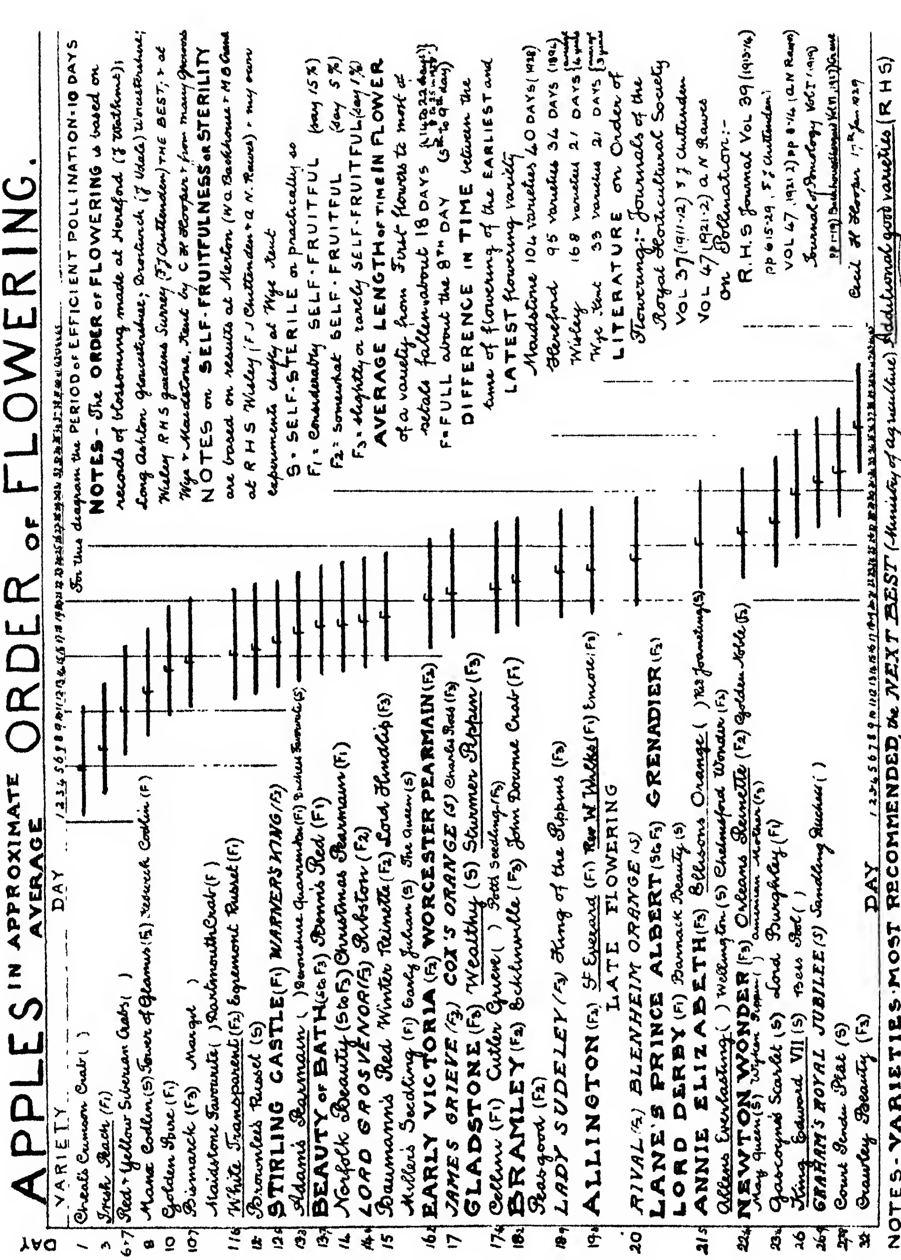
APPLES.

Although a considerable proportion of apples are gradually being shown to be more or less self-fruitful (under glass, varying from 7% down to 0.2%),



Approximate order of flowering of Pears.

yet all experimenters agree that no single variety can be advantageously planted alone and that all varieties yield more if interplanted with one or more varieties in flower at the same time. Even the most self-fruitful variety will yield three or four times the crop with other varieties than if planted alone.



Approximate order of flowering of Apples.

In 1910 I placed three paper bags over unopened blossoms on trees of 63 different varieties of apple, with the following results:—1. with insects excluded only "Irish Peach" matured fruit; 2. flowers pollinated with own pollen, eleven varieties matured fruit; 3. flowers pollinated with a different

pollen, forty-eight varieties matured fruit. These were single trials in each case, but my experience since is that this gives a fairly correct idea of apple pollination in the open air. Among the varieties found most self-fruitful are:—Stirling Castle; Rev. W. Wilks; Golden Spire; Irish Peach; Christmas Pearmain; Baumann's Red Winter Reinette; Ben's Red; Miller's Seedling; Lord Derby; White Transparent and Tower of Glamis, but with many trials I have never persuaded Cox's Orange or Lane's Prince Albert to mature fruit with their own pollens.

Where a variety has been planted alone in block, it is recommended to re-graft or replace one tree in eight with a different variety flowering about the same time; Bramley's Seedling is found to be a specially good variety with which to re-graft. Each third tree in each third row of a different variety is considered the minimum proportion for a pollenising variety

In planting a new orchard it is advisable to plant not more than two or three rows of one variety and then alternate with another variety.

Experience and experiment show the following to be good varieties to plant together, though other combinations may succeed equally well: Cox's Orange with Worcester; Bramley with Lane's; Newton with Lord Derby; Blenheim with Newton; Early Victoria with Grenadier; Beauty of Bath with Allington; James Grieve with Cox's Orange; Gladstone with Cox's Orange or Worcester. In many trials I have found Cox's Orange to be a good polleniser, the crosses have almost always taken and matured fruit.

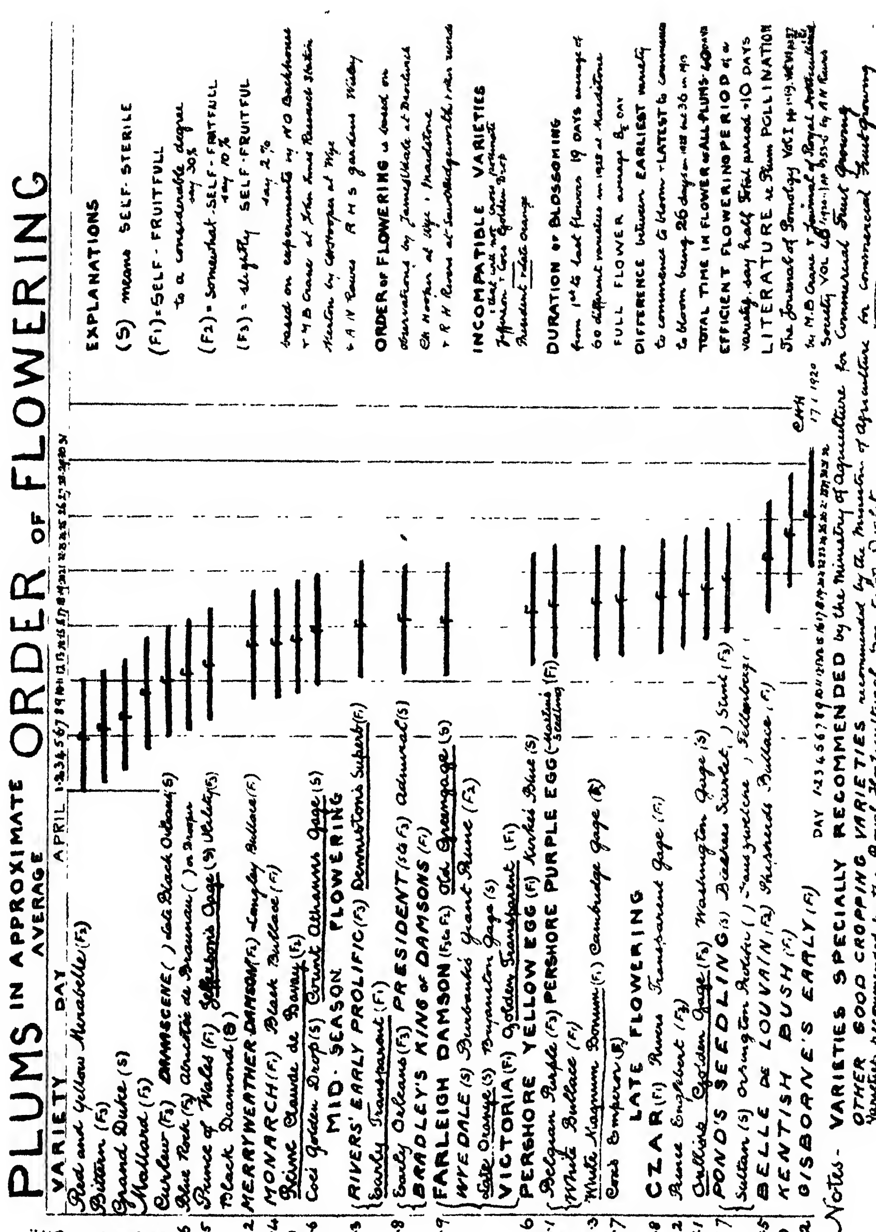
PLUMS.

Plums are grouped according to pollination experiments into three classes 1. those that are considerably self-fruitful; 2. those that are absolutely or very nearly self-sterile; and 3. a few that are partially or slightly self-fruitful. The most self-fruitful group includes:—Pershore Yellow Egg, Pershore Purple, Victoria, Czar, Denniston's Superb, Monarch, Shepherd's Bullace, Kentish Bush, Early Transparent, Prince of Wales, Bradley's King of Damsons and Gisborne.

The partially self-fruitful varieties include:—Rivers' Early Prolific, Early Orleans, Cox's Emperor, Prince Englebert and Belgian Purple, whilst the self-sterile varieties include:—Pond's Seedling, Greengage, Jefferson, Bryanston, Late Orange, President and Coe's Golden Drop.

Of the self-fruitful varieties Pershore Yellow Egg plum fruits perfectly in Worcestershire without other variety, and yields as heavily as potatoes, but all the other kinds yield more heavily if pollinated with pollen of another variety.

Some suggestions based on pollination experiments and orchard practice may be found useful. Rivers' Early Prolific crops well with Prince of Wales, Czar or Monarch; Pond's Seedling with Czar, Kentish Bush or Belle de Louvain; Belle de Louvain with Czar or Kentish Bush; Monarch with Rivers' Early



Approximate order of flowering of Plums.

Prolific or Prince of Wales; President with Czar; Victoria with Czar; Oullin's Golden Gage with Pershore Purple.

For the three specially shy bearing kinds Mr. M. B. Crane of the John Innes Horticultural Institution tells me that for Coe's Golden Drop he has found

Pond's Seedling, Rivers' Early Prolific and Monarch to be good pollenizers; for Greengage he has found Pershore Yellow Egg, Pond's Seedling, Czar, Early Orleans or Bradley's King of Damsons to be good pollenizers and for Bryanston Gage, Rivers' Early Prolific. At Wye there is a fruit garden of several acres enclosed by a circular wall about nine feet high; on this wall are trained trees of different varieties of plums, and there are three hives of bees in the garden. These shy bearing plums all fruit here almost as plentifully and regularly as the Victoria.

Mr. Crane finds that:— (1) President, Late Orange, Cambridge gage are inter-sterile; also (2) Coe's Golden Drop and Jefferson, so these several sorts are unsuited to plant together alone for cross-pollination.

CHERRIES.

The Agricultural College of Wageningen, Holland, has just published a pamphlet on cherry pollination which ends with the following advice to cherry growers:

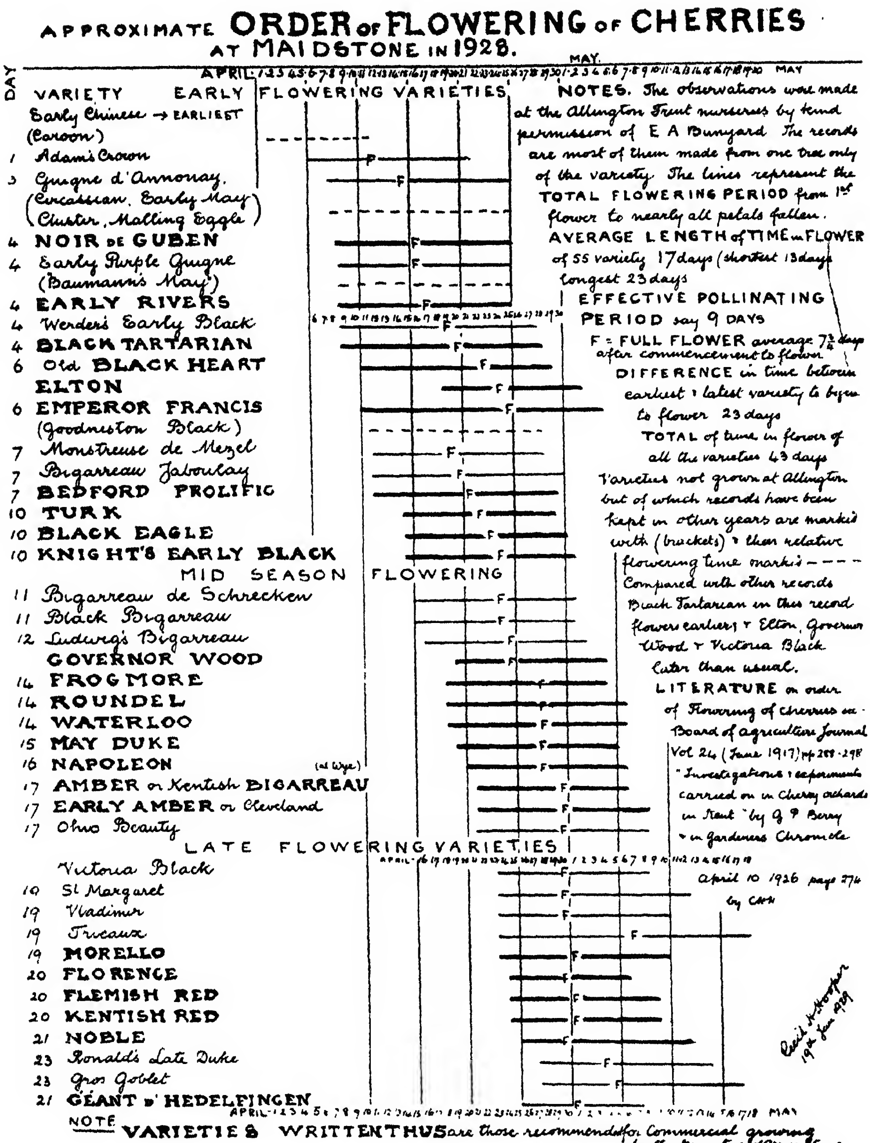
1. In planting an orchard, plant two or more varieties in such a way that every tree of one variety has a tree of another sort next to it on one side at least.

2. Keep a good number of hive bees in the cherry orchard during the blossoming period.

In 1913 Mr. V. R. Gardner, of the Oregon Agricultural College Experiment Station, published a bulletin showing that different crosses in cherries gave different yields; besides showing that sweet cherries were in general absolutely self-sterile, he proved that the three chief varieties, Bing, Lambert and Napoleon were inter-sterile, *i.e.*, would not cross-pollinate each other. Investigations in England at Merton and Wye have shown that most of the sweet cherries are absolutely self-sterile, or if at all self-fruitful only to the extent of about one per cent., which does not help much towards a crop; cross pollination is therefore of very great importance in sweet cherries.

The Duke cherries are slightly self-fruitful and appear to be best pollinated by other Duke varieties and by Morello. Flemish and Kentish Red preserving cherries are somewhat self-fruitful, but need cross-pollination. There is a plantation of Flemish cherries near Ramsgate which has been inter-planted with Kentish Red; the crop is generally good and regular, so this seems to be a good practice. The Morello cherry is perfectly self-fruitful; nothing is gained by cross-pollination; this is the only cherry that can be safely planted alone.

Mr. M. B. Crane, at the John Innes Horticultural Institution, in his valuable investigations has found that among the varieties grown in England there are groups of cherries that are inter-sterile, and that one should avoid planting them together alone. These are:—1. Early Rivers, Knight's Early Black, Bedfordshire Prolific, Black Tartarian and Black Eagle. 2. Frogmore, Waterloo, Guigne de Winkler and Bigarreau de Schrecken. 3. Napoleon and Emperor Francis.

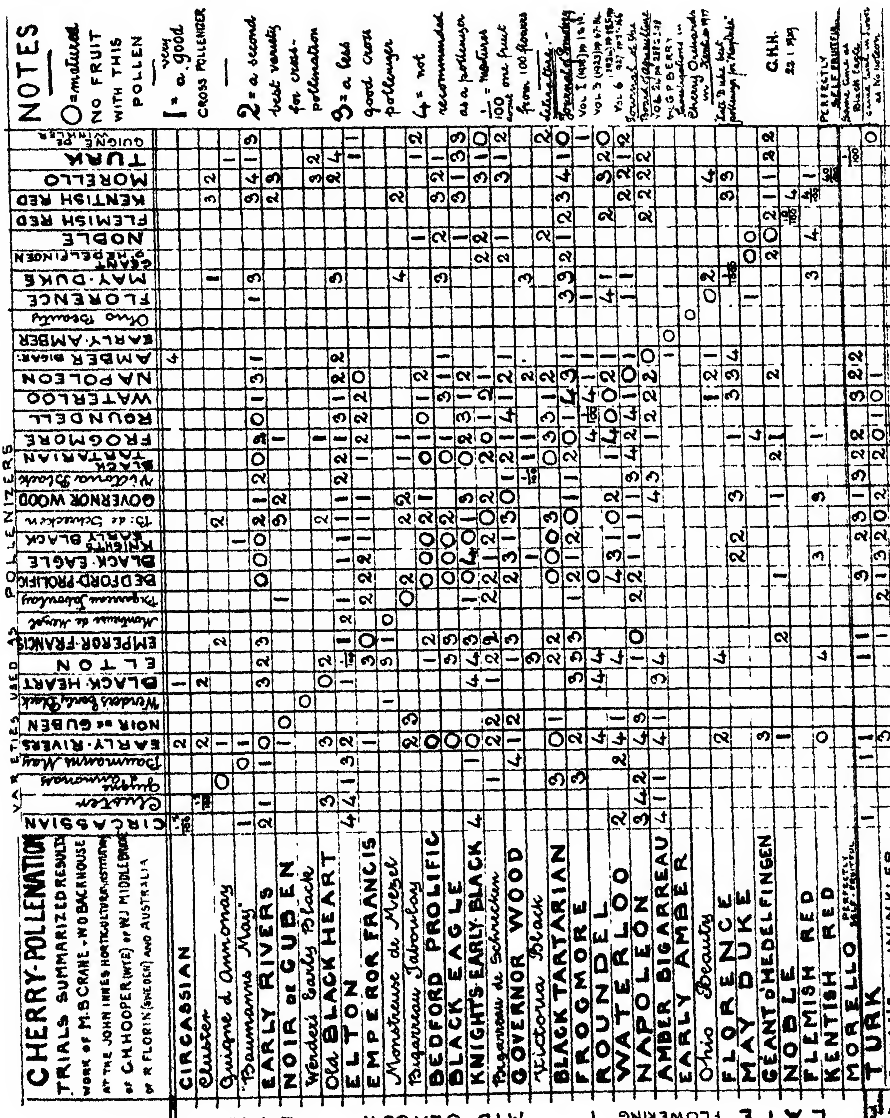


Approximate order of flowering of Cherries.

Early Rivers being the most profitable cherry has sometimes been planted alone in large quantities, when it is found that the inside trees bear very little fruit. Some growers (Sir Walter Berry at Selling, Mr. A. J. Thomas at Rodmersham, and Mr. H. Stevens at Wye) have each found that a variety

known as "Baumann's May" is a good cross-pollenizer for Early Rivers; it flowers at the same time and the fruit is ripe soon after Early Rivers, which it resembles.

In choosing varieties to plant together one needs to avoid planting early flowering with late flowering varieties alone; a mid season flowering sort might pollenate both the early and the late flowering varieties, bridging the difference in time of flowering.



Chart—showing results of cross-pollination of Cherries.

I have made a table collected from the results of experiments and orchard observation from several sources which I hope may act as a guide in choosing varieties suitable to plant together.

The most productive cherry orchards I know are planted with several varieties, and bees are kept in the orchards. If one cannot manage to have one hive per acre, have a hive to five acres. It will be found to be far better than having none.

An excellent bulletin on "Pollination and Growing of the Cherry" by C. E. Schuster was published in 1925 by the Oregon Agricultural College Experiment Station.

INSECT VISITORS TO FRUIT BLOSSOMS.

I had hoped this evening to devote a good deal of time to the insect visitors but the length of the paper does not allow it.

There are a great many different kinds of insects that visit fruit blossoms, especially the apple.

For several years I made brief notes of those I noticed and added up their numbers, which are given in the attached table. I am glad to say since I made my observations as a mere naturalist, Mr. J. Fox Wilson, as a trained entomologist, has made a far more complete list at the Royal Horticultural Society's Gardens, at Wisley, Surrey, and I would refer anyone interested in the subject to his well-illustrated report in the *Journal of the Royal Horticultural Society* for 1926.

Mr. Fox Wilson's and my records differ in some ways. The Royal Horticultural Society's gardens are surrounded by common and woods; there was not a large acreage of fruit, and the nearest hive of bees was about three-quarters of a mile distant, so wild insects were very numerous and hive bees not so numerous. At Wye there is a considerable acreage of cherry, apple and other fruits, and a good many hives of bees are kept; the surrounding land is arable land and sheep pasture, which are not very favourable habitats for pollinating insects.

All entomologists who have studied the subject of fruit pollination agree that the bee family, owing to the structure of the insects and their habit of keeping to one kind of flower on a journey, are by far the best fruit pollenizers of all insects.

The bumble bees and the small wild bees do splendid work, but they are out of human control and cannot be increased in number. With high cultivation wire fences replace hedgerows; so that the banks and woods where the wild bees make their home decrease in area; thus the hive bee relatively increases in value.

Where there are large blocks of fruit the pollination by insects is out of proportion to the capacity of the local wild insects, and it is therefore of great value to place hives of bees in different parts so as to have them near the black

NUMBERS OF DIFFERENT KINDS OF INSECTS VISITING FRUIT BLOSSOMS.

Fruit.	Hive bees.	Bumble bees.	Small wild bees (Andrena & Halictus).	Blue bottle flies.	Other flies.	Beetles.	Ants.	Earwigs.	Thrips.	Other Insects.	Notes.
Almond ...	6										
Peach ...	9	5		2		1					
Pear	172	2	11	16	2					3	(2 midges, 1 white butterfly).
Plum	23	17	35	2	1						
Gooseberry ...	57	17	1		1					1	(1 wasp) (1 yellow fly).
Cherry ...	103	92	16							1	(1 spider).
Red Currant ...	10	1			1						(1 yellow fly)
Black Currant	36	12	5							1	
Apple ...	374	37	21		23	104	51	3	2		(beetles include 24 weevils)
Strawberry ...											a few hive bees
Raspberry ... (recorded by Mr. H. Chapelow)	707	32			24						
Loganberry ... (recorded by Mr. H. Chapelow)	1292	61			79						
Quince... ...	4						many				

Recorded by C. H. Hooper at Wye, Kent.

currants and cherries and other fruit to carry pollen when the weather is suitable.

The American fruit growers keep bees extensively for the fertilization of the blossoms rather than for the honey. In England one finds that many of the most painstaking and successful fruit growers keep bees with the object of increasing their crops.

It is advisable to distribute the hives rather than to have them all in one spot, the ideal arrangement being one hive to each acre of fruit.

It may be found practicable to take hives to fruit plantations just before blossoming time, and afterwards to remove them to where there is more diversity of flowers, in the same way that hives of bees are taken to the heather moors. I have for three years taken out a hive to a cherry orchard just before blossoming time, and brought it home after flowering was over, with satisfactory results.

It is said that bees fly from their hives against the direction of the wind and have it with them when returning laden with pollen and nectar, so that it may be advisable for hives to face the direction of the prevailing wind.

It is important to have the bees in the hive strong and in large numbers ready for their work in the early spring, the bees should, therefore, be left with sufficient food in the autumn for the winter, and will be benefited by being given syrup in early spring.

There are three ways of managing the bees on a fruit farm :— (1) For the owner to look after them ; he may not have time or may not like bees, so (2) he can get one of his men to look after them, giving him a little higher wage ; (3) he can allow a bee-keeper to keep his hives in his orchards or even pay him, say, 5s. a hive, for the use of his bees for his fruit.

I asked Messrs. Chivers & Sons, of Histon, Cambridge, their opinion about bees, and Mr. H. J. Chivers very kindly replied : " I am afraid that, unlike our American friends, we are unable to state very definitely the effect of bees on the pollination of fruit. To our minds, it entirely depends on the type of weather just before and during the flowering of the fruit as to whether the bees are actually a great deal of good or not. However, as we keep about 500 stocks of bees, you will realise that we do believe in them."

Conclusion.

To summarise this paper, the points I wish to emphasise are, that if there are not sufficient wild insects, especially bumble bees and the small wild bees, in the neighbourhood to pollinate the crop efficiently, persuade someone to bring his hives of bees to your plantation and have the honey he gets as his reward.

2. In planting a plantation or orchard of fruit trees choose two or more varieties that flower about the same time, avoiding planting together varieties of cherries that are inter-sterile.

3. Where trees of one variety have been planted in large numbers inter-plant or re-graft one tree in nine with another variety in order to get cross-pollination.

Finally, I have to thank Mr. F. I. Neame and Mr. H. Stevens for allowing me the run of their farms in which to make experiments, and answering many questions, also Mr. H. S. Rivers and Mr E. A. Bunyard for making records of the order of flowering ; I thank Mr. F. J. Chittenden, Director of and Mr. A. N. Rawes, Experimenter of the Royal Horticultural Society's Gardens, also Mr. M. B. Crane for much of the information included in this paper, also Mr. F. Edenden, of Wye, who made most of the lantern slides.

DISCUSSION.

The Chairman, in opening the discussion, remarked that the side of the subject in which he had been more particularly interested was that of the effect of the weather on the growing of fruit ; and illustrated his remarks by means of a lantern slide of a pear blossom, showing how unfavourable weather adversely affected the germination and growth of the pollen grain.

Mr. G. Fox Wilson (Royal Horticultural Society's Laboratory, Wisley) said he was particularly interested in the paper from an entomological point of view, as there had been carried out at Wisley for some years close observations on the insect visitors to fruit flowers. Wisley was surrounded by a good deal of wild country, and it had been found that hive bees had played very little part in the pollination of the fruit trees there. In 1919 and 1920, when detailed observations were first commenced, hive bees had been entirely absent, yet during those years excellent crops of apples, pears and plums had been obtained, due wholly to wild insects, particularly humble bees In 1921 hive bees were present in quantity, but during bad weather, cold winds and heavy rains they had not worked; whereas he had found the humble bees working extremely industriously. In the same year he had paid a visit to a very large fruit farm in Essex on a pouring wet day. He had been on the fruit farm from 10 a.m. to 4 p.m., during which time it had never stopped raining, and there had not been a single hive bee about; but he had seen humble bees busily engaged in pollinating flowers. He did not want to minimise the importance of hive bees, but it should be realised that in certain localities in which some fruit farms were placed, such as Wisley, the work depended mainly or entirely on humble bees, and other wild bees and certain flies In the case of pears, blue-bottles were extremely useful.

The Chairman remarked that he wondered what the country would be like if everybody propagated the humble bee in all the fruit plantations. He was glad to hear Mr. Fox Wilson say a good word for blue-bottles. It was the only time he had ever heard any good of them. Mr. Grainger was present--a gentleman who always managed to get regular crops of Cox's Pippins and perhaps Mr. Grainger would tell the audience how he did so.

Mr. H. Grainger said he could not say a great deal on the matter of how he managed to obtain regular crops of Cox's Pippins. The longer he went on, the more he felt that he could not express an opinion as to how things did come about. For instance, in 1917 there had not been a hive of bees anywhere in Essex, and yet it had been one of the biggest fruit years, with the finest sets he had ever seen. He had been very interested in what the Chairman had said about the weather, because personally he thought that had a great deal to do with the matter. In 1918, for example, there had been very few apples about Owing, no doubt, to the dull, moist weather, there had been no circulation of the pollen. One important matter to pay attention to was the health of the tree The healthier a tree was the better the set, and the better the distribution of the pollen. He had not noticed that fact until the last year or two, when he had some trees which were not so healthy as they should have been. Those trees had a good deal of bloom, but very few sets at the finish; and he was inclined to think that their less healthy condition had a good deal to do with it. It was true that he had had good crops of Cox's Pippins year after year. In 1920, for instance, he had a good crop, although no other variety was in flower until after Cox's; even Worcester (which is supposed to be helpful), had not come into bloom; this result had puzzled him much and he could not understand it.

Mr. W. Rogers (Past Chairman, East Malling Research Station) agreed with Mr. Grainger that the health of the tree had a great deal to do with the cropping of it, but he thought there was a gentleman who had also a great deal to do with the cropping of the fruit tree, and that was Mr. Jack Frost. With the weather conditions good, one generally got a crop. He himself had been favoured with a

good crop of Cox's Pippins in 1918, but he was bound to say that since then his Cox's had been very shy. He could not say why, because they were planted in amongst Worcester Pearmains, and other varieties, which were supposed to be suitable. Certainly he should say, as a practical fruit grower, that while the Bramley Seedling or the Newton Wonder would buy the horse, the Cox would not buy the bridle. In relation to cherries, he knew of a large orchard of very well-grown trees planted a number of years ago at Kingsdown, which very rarely grew a crop of cherries. He had been speaking to the present tenant lately, who said that he found by inter-planting he was gradually getting small crops there; but it was really a tragedy to see those beautiful trees growing and blossoming profusely, but with no result. That plantation was in one of the coldest districts in Kent, and he thought Mr. Jack Frost had stepped in there. He agreed with the Chairman that weather conditions had an enormous influence on the cropping or otherwise of the fruit. He would like to ask the lecturer the variety he thought was best to inter-plant with Doyenne du Comice. He had a row of Doyenne du Comice which made a very handsome picture, but whose fruit-bearing qualities were almost nil.

Mr. Spencer Mount said he had quite an open mind on the question of planting different varieties together. It was a matter which had rather worried him once or twice. He agreed with Mr. Grainger that a lot depended on the vigour of the tree and on the vigour of the fruit bud at the time of flowering. He had experimented once with some apple trees of the variety of Bramleys, Beauty of Bath and Gladstone—which one would say were not self-fertile varieties. He had cut those trees down very hard. He had cut more than half the wood off, and more than half of the fruit buds. When they had come into flower, the flower had been very bold on all of those trees, and it was a most remarkable thing that without exception every flower on all three varieties had set. There had been five Bramleys in a clump, five Beauty of Baths in a clump and five Gladstones in a clump—an occurrence which one never came across ordinarily in trees. It had struck him that it was not so much the cross pollination of different varieties, as the vigour of the fruit bud. By cutting the trees down by half, more vigour went into the fruit buds which were left. He had been on Mr. Grainger's plantations where the trees were very healthy. Mr. Grainger pruned them hard every year, and no doubt all his buds were very healthy, the result being a crop every year.

Mr. A. H. Hoare tendered his thanks to the author, with whom he had frequently corresponded, and whose letters had always been very helpful. He was very grateful, as he was sure every fruit-grower was, for the work which the lecturer had done and was doing. While pollination was an important factor in fruit production, it was not the only factor. Nutrition was another very important factor. A tree might become so starved that it was unable to develop the crop of fruit which it was called upon to bear. It might carry a good crop of leaves and blossoms, but the amount of favourable food in the soil might be so scanty that it was unable to produce the crop of fruit which, other things being equal, it would have produced. Another factor of importance was that of disease. That was equally as important as nutrition. They had recently taken some evidence in Cambridge bearing on the health side of the question, and it had been shown that repeated doses of a disease on an apple tree would throw it out of bearing altogether. Results had been taken over a number of years, and a stage had been reached where the control trees repeatedly attacked by apple scab had been

unable to bear fruit; whereas those trees which had been sprayed, and where attempts had been made to control the disease, were producing a crop yielding a profit of £50 per acre. That was one of the most important discoveries of recent years in the matter of fruit production. Everyone knew that Jack Frost was a very important gentleman. Mr. Grainger had referred to a point which might leave one or two rather mystified, and that was how he produced Cox's Orange Pippins in a year when there had been apparently no pollen about to produce cross pollination. He desired to mention the following point as bearing on that. There was a young scientist at Cambridge who was also an amateur aviator. He had been going up in an aeroplane several thousand feet, and exposing gelatine plates in order to see what he could find in the way of germs of disease or anything living, and he was producing some very interesting information. For instance, he had exposed gelatine plates several thousand feet above terra firma, and he had obtained pollen of all sorts, which showed how far these minute grains of pollen might be scattered by the wind. All fruit trees were wind pollinated as well as insect pollinated. Grains of pollen would sweep through the atmosphere probably for miles if the wind was favourable, and that was what he thought had really happened in such a case referred to by Mr. Grainger.

The Lecturer, in reply to Mr. Rogers, said he could only say what he had found successful with cross pollinating Doyenne du Comice. He had tried various different kinds of pollen, and the ones which he had found most successful were Hessle, Fertility and Triomphe de Vienne. He knew of cases, also, in which Glou Morceau had been found good by some growers.

With regard to bees, there was one small point he would like to mention, and that was that if the hives were actually on the spot the bees were ready to come out at a few moments' notice when the weather was fine; they were actually there on the ground to do their work. He had been very interested to hear Mr. Fox Wilson's remarks on that side of the question. Mr. Fox Wilson, however, dwelt in the midst of a beautiful district surrounded by moors, commons and woods, in which wild Nature was at its very best in the way of pollination. In many parts of Kent one found 50 or 60 acres of fruit where the woods and the banks had gone. He was absolutely certain that if one had a plantation of five acres of gooseberries, and one put down a hive in the middle, a heavier yield would be certain to be obtained, and the same with black currants. It depended on the balance of Nature to some extent. He had been extremely interested at hearing about the young Cambridge scientist finding pollen grains in the air. That was well worth thinking over. It was very strange that the Americans had experimented on the transference of pollen by the air. They had taken off the petals from thousands of blossoms and had left them open to the transference of pollen by the air, and they had reported that there was not one case in 10,000 in which the fruit set; the insects did not go to the blossoms when the petals were off.

If anybody had any questions they would like to ask of him he would be only too glad to reply. His interest was to help fruit farmers. He would be only too pleased to try to solve any problem which was put to him. If only the practical man and the scientist would work together, in a very short time a great deal of information would be gathered together.

The Chairman, in proposing a hearty vote of thanks to the lecturer, said it was interesting to remember that Mr. George Norgate Hooper, the father of the lecturer, had been a Fellow of the Royal Society of Arts for nearly fifty years, and

had read several papers in that room. It was also interesting to note that the present lecturer had started work on the question of the pollination of fruit trees as early as 1908. He had been carrying on that work ever since, and those present were very much indebted to him for having come and given them an account of his original life work—certainly work which had extended over at least twenty years. If one looked at the tables which were exhibited on the wall, and if one studied the enormous amount of detailed observations which must have been made to get the exact dates of flowering of each of the varieties which had been mentioned that night, one would be able to gauge the enormous time and detailed work which the lecturer must have devoted to the subject; yet he brought it all forward and laid it bare to the world in order that the fruit growers of the country might derive benefit from it. It was a very important subject, which had only just started to be tackled, involving at least three big sciences. The great amount of work which men like the lecturer were putting into it would rank as pioneer work, and he wanted the audience to join with him, for the reasons he had stated, in passing a very hearty vote of thanks to the lecturer for his excellent paper, and for the very interesting evening which he had given them.

The vote of thanks having been carried unanimously, the meeting terminated.

BRITISH INDUSTRIES FAIR

British Industries Fair: White City. Not only should we not be surprised, we should not be indignant, either, when a salesman says, pointing to some of his wares: "These are very beautiful; we've been selling a lot of them lately" For this is the most respectable *non sequitur* of the present day There is no doubt also a touch of up-to-date psychological science in the nonchalant assurance with which the salesman speaks, he is bringing the pressure of suggestion to bear on his possible customer. "Forty million Britons can't be wrong," says a contemporary advertisement, so casting the lie in Ibsen's teeth; for Ibsen said: "The minority is sometimes right: the majority is *always* wrong."

A salesman at the White City picked up a tea-cup to show me, of which the only beauty, and that only from his point of view, was its alleged popularity The brim of this cup was so artfully twisted about that only somebody with a knack could hope to avoid spilling half the liquid contents when drinking Every conceivable shape of pot, and every conceivable decorative design for pots was to be found at the White City—except some of the simpler and better ones in each case. If one had had to choose an ingenious and fantastic set, I should have given my vote for the work of an Irish firm, the Fermanagh Pottery Company, whose more delicate pieces have a pearl-like glaze inside On the other hand, a good sensible line, I thought, was that displayed by the Pearl Pottery of Hanley; simple shapes, a blue-grey colour—not unlike that of Messrs. Wedgewood's well-known lavender ware—and not too high a glaze.

The glass in general was inoffensive. One booth showed that the influence of Lalique has not been altogether rejected by British industry, but the designs themselves were very poor. Some large, round, painted flower bowls, exhibited by Messrs. Walsh of Birmingham were really attractive, and the glass fittings in the special section organised by the British Institute of Industrial Art were very satisfactory.

This special section was, as might have been expected, of great interest. The most discriminating foreign critic could not, if only on its account, have left the Fair with feeling anything but respect for our industrial art. Here, in some

sort of an *ensemble*, was arranged a selection of furnishing textiles, metal work, furniture and various accessories. The wrought-iron garden gate by the Stepney Craft School, an agreeable piece of work, acted as an entrance to one wing of this exhibition within the exhibition. The eye was then immediately caught by what is described as a "cast-iron mantel register gate," designed by Professor Lethaby. This had a fellow in the other wing, a slightly larger and equally fine grate, with architectural lines and a sober pattern. Here some curtains might be seen, designed by the most versatile of our men of taste, Mr. Roger Fry. The textiles were mostly good, both those which depended on their pattern and those which depended on their sheen. The furniture, too, was on a high level, though the simplicity in which the pottery was lacking is not by itself enough to be the making of a work of art where sideboards are concerned. Messrs. Russell, of Broadway, showed a civilised bedroom suite, and Messrs. Peter Jones a set of cane-bottomed chairs and a settee which would be excellent in the appropriate environment. A dining-room table was perhaps the best exhibit of the Bath Cabinet Makers, Ltd., and the walnut sideboard of this firm was almost very good.

If an office has got to be sleek and solid, and if someone in it has really got to do a great deal of work, the claims of the biggest table shown by Messrs. Globe-Wernicke should be very strong on the selector. This massive exhibit, the absolute antithesis in spirit of the Bureau du Roi and of the seventeenth and eighteenth centuries, recaptures in its proportions the humanity which it loses in its immaculate machine finish.

A small but interesting booth was that of Messrs. Myers, a London firm specialising in ivory goods. Just as the makers of Oxford Marmalade have proved that a jam-pot can have a good shape, so Messrs. Myers prove that a shaving brush or a manicure set in ivory can be satisfying without the least effort being made to allure the eye with frills. Their wares look as "high class" as they are described to be, and made the present reviewer's mouth water as much as anything at the White City.

Messrs. Ortweiler appear to have the same instinct for the intrinsic potentialities of leather that Messrs. Myers have for ivory. Their booth was not a booth, but an entire workshop, with large showrooms attached, yet in their range of exhibits one could not find much that seemed a mere concession to popular taste, or lack of taste

The size of the Fair made it impossible for a short review to do more than touch on a few points. British toys are an interesting subject; the more elaborate ones are so good: could we not produce better simple ones? There is still more individuality in German toys than in ours.

In printing, too, we are behind the Germans: not, under the circumstances, that there is any disgrace in this. Perhaps the increasing interest in book production which may be diagnosed at home will gradually lead to our excellent typographers being given a freer hand by their chiefs. If we discourage them too much they will be off to the Continent or to America, whence they are certainly the recipients of tempting offers.

EXHIBITION OF ENGLISH DECORATIVE ART.

LOAN EXHIBITION OF ENGLISH DECORATIVE ART. LANSDOWNE HOUSE.—The setting in which so many treasures are exhibited is a splendid one, a mansion built by Robert Adam himself. The actual arranging has been done with great skill, but even these grand eighteenth century halls are overcrowded with such

a wealth of furniture, tapestry and silver. But with a little imagination it is possible to re-sort the different pieces, and to construct in one's head several really "ideal homes."

The range of the exhibition is wide. The Guild Chair in Room I is mid-fifteenth century; there is a tapestry panel in Room IX, lent by Her Majesty the Queen which was woven for Queen Victoria about 1880. It is in tapestry that the show is most rich; there is much fine silver, but not a correspondingly remarkable collection of furniture. Hepplewhite is not represented. Nor is all the late eighteenth century work as perfect as we might expect of the period; on the other hand, some of the nineteenth century tables and chairs are charming. The wax flowers, No. 366, must not, indeed, cannot be missed, and visitors should not overlook the perpetual motion clock in the last room, which had just stopped, apparently for the tenth time that morning, as I was passing.

Sir Joshua Reynolds' portrait of Sterne looks down on what is one of the most attractive groupings of all. Two wool and silk panels, with a design of flowers and birds, woven in London about 1723, flank a gilt gesso table with cabriole legs dating from approximately the same time. The effect, heightened by a lovely bowl of tulips, is all one could desire—aesthetic, luxurious and reposeful. The red and orange needlework hanging, No. 212, is a copy of a tapestry of the same set as two panels mentioned above; it has, however, a more emphatic character, and pleases in rather a different way.

No. 245 is as feminine as No. 212 is masculine; it consists of embroidered bed curtains and valances, the designs in many coloured silks being on pink silk, and said to have been worked by Mary Blount, who married the ninth Duke of Norfolk in 1727.

For the grandest manner of all we must go back to those astonishing products of the Sheldon factory, called the Hatfield Seasons, Nos. 33 and 36, which were based on designs of the Fleming, Martin de Vos. It is interesting to compare them with work from the Royal factory at Mortlake, which was founded in 1620, nine years after the Hatfield Seasons were completed. No. 106, the "Miraculous Draught of Fishes," based on the cartoon by Raphael (secured by Charles I on the advice of Rubens), is a great contrast to the Sheldon tapestries. Aesthetically the latter could hardly be more satisfactory. The designs are closely knit and most skilfully distributed. They are in complete harmony with the texture of the material on which they are woven. A delightful, though less important pair of panels, Nos. 242 and 244, bear witness that a more sparse and intermittent pattern can be successful; it is not, therefore, the size but the disposal of the masses in No. 106 which is not altogether agreeable. The historical importance of this piece is greater than its intrinsic beauty.

The cabinet makers of this country have produced few finer pieces than the satinwood commode, No. 277, "probably Chippendale," and the semi-circular cabinet in satinwood, tulip-wood and mahogany, by Sheraton, No. 310. The architectural quality of the former, the suavity and refinement of the latter are evident at a first glance; yet they must be very pleasant to live with, and would doubtless improve on acquaintance. There is nothing forced or overloaded about such work, as in the case of much magnificent French furniture of the same period. The lines are simple, yet exquisite; elegant, yet strong.

An agreeable example of primitive sophistication is No. 81, an Elizabethan four-poster bed in carved oak. Needlework hangings and a spread of a hundred years later have been added, and help to make a most attractive whole. The period of oak is also well illustrated by a cradle, a dining table, a court cupboard and an extremely fine chest, while many cushion covers, of just the right coarseness of

texture and niceness of design, suggest the robust culture of the early seventeenth century in England.

Many of the silver exhibits are of an impressive size; one could comfortably have a bath in one piece lent by the Duke of Portland. But there is dignity here, as well as bulk, and if it were not for the fact that demand for such goods is limited to-day, one would recommend the student of the craft to make careful notes of this section.

Among the curiosities are a pair of portraits—Collingwood by Nelson, and Nelson by Collingwood. The two admirals met at Antigua, and amused themselves in this very civilised way; nobody was ever less of the bluff bulldog than the most august of our national heroes. We know from his despatches that he was exceptionally broad minded; we can see now that he knew how to use a pencil.

A general comment on the loan exhibition which may strike some modern designers as a little disingenuous is that it is a very human show. There are three courses before applied art to-day. Machines might be dispensed with as far as possible. This is not sensible or possible. Man might be further mechanised; his belongings might be clearer reflections of the machine age than they are. This is against reason and taste. Machines, on the other hand, might be humanised; used, that is to say, with greater discretion and individuality. This is the proper compromise. No great artist in any department of art has ever belittled the wisdom of the past; and because our English traditions are so valuable we must be grateful to all those who have lent their beautiful things for the public to see at Lansdowne House, and to Mr. Selfridge, for lending the house itself.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

[illegible] MARCH 11. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C., 6.30 p.m. Wing-Commander G. B. Hynes, "Engine Performance Tests."

Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham. 7 p.m. Mr. H. Kerr Thomas, "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C., 7.45 p.m. Mr. W. F. Ball, "Refrigeration as applied to Beer and Water Cooling and Cold Storage in Breweries."

Chadwick Lecture, at the Royal Society of Arts, Adelphi, W.C., 5 p.m. Mr. G. Mowlem Burt, "The Making of a Modern Building." (Bossom Gift Lecture.)

East India Association, at Caxton Hall, Westminster, S.W., 4.30 p.m. Sir Walter Willson, "Europeans in India and the Reforms."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne, 7 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture.)

Geographical Society, Lowther Lodge, Kensington Gore, S.W., 5 p.m. Mr. A. Broughton Edge, "Methods of Geophysical Exploration."

Heating and Ventilating Engineers, at the Borough Polytechnic, Southwark, S.E., 7.30 p.m. Mr. J. H. Bryant, "Sprinklers."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds, 7.30 p.m. Prof. Dr. C. H. Desch, "The Nature of Hardness." (Joint Meeting with Society of Chemical Industry.)

Metals, Institute of, at 39, Elmbank Crescent, Glasgow, 7.30 p.m. Mr. M. Parkin, "The Anodic Treatment of Aluminium for Corrosion."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C., 5.30 p.m. Mr. H. N. Gresley, "Rail Motor Car Developments."

University of London, at King's College, Strand, W.C., 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture III.)

At the London School of Economics, Houghton Street, W.C., 5 p.m. Mr. Paul Vaucher, "Present Aspects of French Politics." (Lecture IV.)

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C., 5.30 p.m. Prof. F. Fulleborn, "Some Questions of Tropical and Local Helminthology." (Lecture I.)

At University College, Gower Street, W.C., 5.15 p.m. Prof. Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture II.)

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture V.)

5.30 p.m. Miss Edith C. Batho, "Scandinavian Influences in England since the 17th Century." (Lecture II.)

TUESDAY, MARCH 12. Electrical Engineers, Institution of, at the North British Station Hotel, Edinburgh, 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Marine Engineers, Institute of, 85/88, The Minories, E., 6.30 p.m. Dr. F. V. Telfer, "Merchant Ship Service Performance Analysis."

Mechanical Engineers, Institution of, at the National Oil Refineries, Skewen, 6.30 p.m. Mr. W. C. Mitchell, "Engineering Practice in Oilfields and Refineries."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C., 5.30 p.m. Mr. G. Heseldin, "Drilling for Oil with a Diamond Drill."

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C., 8.15 p.m. Sir Henry Slesser and Dr. C. Delisle Burns, "Church and State in Western Civilization."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Stanley W. Kemp, "Antarctic Whaling Expeditions."

Transport, Institute of, at 200, Buchanan Street, Glasgow. 7.30 p.m. Mr. J. Cuthbertson, "Canada and some of its Transport Problems."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture IX.)

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C. 5.30 p.m. Prof. F. Fülleborn, "Some Questions of Tropical and Local Helminothology." (Lecture II.)

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture I.)

WEDNESDAY, MARCH 13..Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. C. Adams, "Bonding and Anchorage of Reinforcing Steel in Concrete."

Goldsmiths, Worshipful Company of, Goldsmiths Hall, E.C. Prof. R. Y. Gleadowe, "Line and Form in Silverwork and other Applied Arts."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

Mechanical Engineers, Institution of, at the Grand Hotel, Sheffield. 7.30 p.m. Mr. A. P. Hague, "Alloy Steels at Ordinary and High Temperatures."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 12.30 p.m. Professor P. Saldau, "Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems." F. Hargreaves and R. J. Hills, "Work-Softening and a Theory of Intercrystalline Cohesion." G. B. Brook and G. H. Stott, "Note on the Testing of Electro-deposits on Aluminium." 2 p.m. to 4 p.m. Dr. P. J. Durrant, "The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold." Dr. Marie L. V. Gayler and G. D. Preston, "The Age-Hardening of some Aluminium Alloys." Clement Blazey, "Brittleness in Arsenical Copper—II." Dr. P. J. Durrant, "A Note on the Haughton-Hanson Thermostat: A Method of Fine Adjustment." Dr. W. Hume-Rothery and E. Rounsefell, "The System Magnesium-Zinc."

North-East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-on-Tyne. 7.15 p.m. Mr. M. Waters, "The Problem of High Voltage Measurement."

United Service Institution, Whitehall, S.W. 3 p.m. Mr. J. M. Keynes, "National Finance in War."

University of London, at King's College, Strand, W.C. 5.30 p.m. "The Social Background of History." (Lecture IX.) Mr. H. Avray Tipping, "The English Garden."

5.30 p.m. Prince D. Svyatopolk Mirsky, "Contemporary Russian Literature, 1917-1928." (Lecture IX.)

At the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. W. S. M. Keighly, "Ledger Systems."

At the London School of Hygiene and Tropical Medicine, 37, Torrington Square, W.C. 5.30 p.m. Prof. F. Fülleborn, "Some Questions of Tropical and Local Helminothology." (Lecture III.)

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "Three Swedish Novelists: Fredrika Bremer, Almquist and Rydberg." (Lecture III.)

THURSDAY, MARCH 14..Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. (1) Messrs. T. N. Riley and T. R. Scott, "Electrical Insulating Papers for the Manufacture of Power Cables." (2) Messrs. S. G. Brown and P. A. Sporing, "The Prevention of Ionisation in Impregnated Paper Dielectrics."

At University College, Dundee. 7.30 p.m. Mr. W. Woodiwiss, "Distribution."

Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. L. A. Robertson, "The Relations of William with the Swiss Protestants (1689-1697)."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Percy Wells, "Pre-Tudor Houses and their Furnishings."

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 7.30 p.m. Mr. A. P. Hague, "Alloy Steels at Ordinary and High Temperatures."

At the Engineers' Club, Manchester. 6.30 p.m. Dr. T. B. Morley and H. Pieling, "The Supermiser."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10 a.m. to 1 p.m. H. C. Lancaster, "The Importance of Design, and Setting of Large Kettles used for Refining and Low Melting Point Alloys." Dr. W. Rosenhain and W. E. Prytherch, "An Improved Form of Electric Resistance Furnace." D. F. Campbell, "Recent Developments in Electric Furnaces." 2 p.m. to 4 p.m. C. Sykes, "Alloys of Zirconium—II." Dr. J. Newton Friend and W. E. Thorneycroft, "The Resistance of Zinc to Indentation (a Preliminary Account)." Dr. J. Newton Friend, "The Solution of Plain and Amalgamated Zincs in Electric Batteries." Dr. J. Newton Friend and W. E. Thorneycroft, "The Silver Contents of Specimens of Ancient and Mediæval Lead."

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. (1) Dr. R. S. Morrell, "The Drying of Vegetable Oils." (2) Mr. R. G. Browning, "A Study of Whiting and Linseed Oil."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m. Annual General Meeting.

Refrigeration, British Association of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Paper on "Some Recent Development I.I.B. Research."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Handling and Interpretation of Metaphor."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture V.)

5.30 p.m. M. Marcu Beza, "Byzantine Influences on Roumanian Literature." (Lecture II.)

5.30 p.m. "Czechoslovakia." (Lecture IX.) Mrs. Rosa Newmarch, "Modern Currents in Czechoslovak Music."

At the Royal College of Science, South Kensington, S.W. 5.30 p.m. Prof. F. Langevin, "The Present Position of the Theory of Magnetism." (Lecture III.)

At University College, Gower Street, W.C. 5.15 p.m. Prof. H. Przibram, "Connecting Laws in Animal Morphology." (Lecture III.)

FRIDAY, MARCH 15..Electrical Development Association, British, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Mr. M. V. F. England, "Water Heating Developments."

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Mr. W. Marston Acres, "The Bank of England."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Mr. J. Hamilton Gibson, "Mechanical and Transmission Losses in Marine Engines, Shafting and Propellers."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. V. M. Goldschmidt, "The Distribution of the Chemical Elements."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. John Middleton Murry, "Shakespeare's Dedication."

(King's College.) At 40, Torrington Square, W.C. 5.30 p.m. Dr. Otakar Odlozilik, "The Bohemian Reformation." (Lecture IV.)

At University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture IX.)

SATURDAY, MARCH 16..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. John E. S. Dallas, "Saxon Churches and their Remnants."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

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FRIDAY, MARCH 15th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 20th, at 8 p.m. (Ordinary Meeting.) PROFESSOR A. E. RICHARDSON, F.S.A., F.R.I.B.A., Professor of Architecture, University of London, "Modern English Architecture." THE RIGHT HON. LORD STANMORE, C.V.O., will preside.

SHAW LECTURES.

MONDAY, MARCH 4th, 1929. MR. BEN TILLET in the Chair. SIR THOMAS MORISON LEGGE, C.B.E., M.D., late Senior Medical Inspector of Factories, delivered the last of his course of three lectures entitled, "Thirty Years' Experience of Industrial Maladies (1898-1927)."

The lectures will be published in the *Journal* during the summer recess.

On the motion of the Chairman, a vote of thanks was accorded to Sir Thomas Legge for his interesting and instructive course of lectures

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 6th, 1929. MR. PERCY V. BRADSHAW, in the Chair. A paper entitled "Commercial Art" was read by MR TOM PURVIS. The paper and discussion will be published in the *Journal* on May 17th.

INDIAN SECTION.

FRIDAY, MARCH 8th, 1929. SIR EDWARD D. MACLAGAN, K.C.S.I., K.C.I.E., in the Chair.

A paper entitled "The Indian Peasant in History: an introduction to the Linlithgow Report," was read by MR. W. H. MORELAND, C.S.I., C.I.E., formerly Director of Land Records and Agriculture, United Provinces. The paper and discussion will be published in the *Journal* at an early date.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1929 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years:—

1864. Sir Rowland Hill, K.C.B., F.R.S.

1865, His Imperial Majesty Napoleon III.

1866, Michael Faraday, D.C.L., F.R.S.

1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.

1868, Sir Joseph Whitworth, LL.D., F.R.S.

1869, Baron Justus von Liebig.

1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.

1871, Sir Henry Cole, K.C.B.

1872, Sir Henry Bessemer, F.R.S.

1873, Michel Eugene Chevreul, For. Memb. R.S.

1874, Sir C. W. Siemens, D.C.L., F.R.S.

1875, Michel Chevalier

1876, Sir George B. Airy, K.C.B., F.R.S.

1877, Jean Baptiste Dumas, For. Memb. R.S.

1878, Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.

1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.

1880, James Prescott Joule, LL.D., D.C.L., F.R.S.

1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.

1882, Louis Pasteur.

1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.

1884, Captain James Buchanan Eads.

1885, Sir Henry Doulton.

1886, Samuel Cunliffe Lister (afterwards Lord Masham).

1887, HER MAJESTY QUEEN VICTORIA

1888, Professor Hermann Louis Helmholtz.

1889, John Percy, LL.D., F.R.S.

1890, Sir William Henry Perkin, F.R.S.

1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.

1892, Thomas Alva Edison.

1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.

1894, Sir Joseph (afterwards Lord) Lister, F.R.S.

1895, Sir Isaac Lowthian Bell, Bt., F.R.S.

1896, Professor David Edward Hughes, F.R.S.

1897, George James Symons, F.R.S.

1898, Professor Robert Wilhelm Bunsen, M.D., For. Memb. R.S.

1899, Sir William Crookes, O.M., F.R.S.

1900, Henry Wilde, F.R.S.

1901, His Majesty King Edward VII.

1902, Professor Alexander Graham Bell.

1903, Sir Charles Augustus Hartley, K.C.M.G.

1904, Walter Crane.

1905, Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S.

1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.

1907, The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.

1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.

1909, Sir Andrew Nobel, K.C.B., D.Sc. D.C.L., F.R.S.

1910, Madame Curie.

1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., F.R.S.

1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G. G.C.V.O., LL.D., D.C.L., F.R.S.

1913, His Majesty King George V.

1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.

1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.

1916, Professor Elias Metchnikoff.

1917, Orville Wright.

1918, Sir Richard Tetley Glazebrook, C.B., Sc.D., F.R.S.

1919, Sir Oliver Joseph Lodge, D.Sc., LL.D., F.R.S.

1920, Professor Albert Abraham Michelson, For. Memb. R.S.

1921, Professor John Ambrose Fleming, D.Sc., F.R.S

1922, Sir Dugald Clerk, K.B.E., D.Sc., LL.D., F.R.S.

1923, Major-General Sir David Bruce, K.C.B., D.Sc., LL.D., F.R.C.P., F.R.S., and Colonel Sir Ronald Ross, K.C.B., K.C.M.G., D.Sc., LL.D., M.D., F.R.C.S., F.R.S.

1924, H.R.H. The Prince of Wales, K.G.

1925, Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., M.B., LL.D., F.R.S

1926, Professor Paul Sabatier, Member of the Institute of France, For. Memb. R.S., Davy Medallist, and Nobel Prizeman.

1927, Sir Aston Webb, G.C.V.O., C.B., P.R.A., 1919-24, P.R.I.B.A., 1902-4, F.S.A., LL.D.

1928, Sir Ernest Rutherford, O.M., LL.D., D.Sc., F.R.S.

SIR E. DENISON ROSS'S CANTOR LECTURES.

Sir E. Denison Ross, who is travelling in the Near East, has been delayed by severe weather and will not be back in England in time to begin his course of Cantor Lectures on "Nomadic Movements in Asia" on April 15th, as previously announced. The first lecture will be given on April 22nd, and the three following lectures on April 29th, May 6th and 13th.

REPRINT OF CANTOR LECTURES.

The three Cantor Lectures on "Biology and Refrigeration" by Dr. Franklin Kidd, M.A., D.Sc., recently published in the *Journal*, have been reprinted in pamphlet form (price 2s. 6d.) and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can also be had on application.

FUND FOR THE PRESERVATION OF ANCIENT COTTAGES.

ANNUAL GENERAL MEETING.

WEDNESDAY, FEBRUARY 27TH, 1929.

THE RT. HON. J. RAMSAY MACDONALD, P.C., M.P., in the Chair.

THE CHAIRMAN:—I have been honoured by an invitation to preside over this meeting, and I accept it with the very greatest pleasure. The object of the meeting is to consider and adopt the Report* of the Fund for the preservation of ancient cottages. I think we can all join with great heartiness in congratulating those who have been responsible for the creation of this Fund. All sorts of things are preserved. We ourselves are preserved by our doctors, for good or for ill. Our pictures are being preserved, certainly for good; and we would wish that the operations and the power of such Societies as the National Art-Collections' Fund could be even stronger than they are now. Our large, important, conspicuous, national buildings are preserved by various Societies and various authorities But, ladies and gentlemen, I feel that you all agree with me that those delightful but vanishing cottages scattered over our countryside, each in itself embodying the spirit of its district, should not be allowed to fall into decay, if joint and co operative action can preserve them for posterity. I am not going to take up any of your time this afternoon in expanding or expounding that doctrine, because I have in front of me a considerable list of people whom I am sure you desire to hear; but I should like to say this—that whilst we are all apt to measure progress by figures about this, and figures about that; by things like the cut of our coat com pared with the cut of our grandfathers' or great-grandfathers' coats, none of those measures of progress really touch the heart and the soul of things. Unless we can manage, in a prosperous materialistic age, to keep standards of good taste, standards of spiritual appreciation—those intangible standards which cannot be measured by weights or by rules, but which are things which relate to the spiritual qualities and appreciations—progress may be apparent on paper but it may be very sadly lacking in reality. What we find in our various pilgrimages in search of peace and happiness and beauty in our country, is that so many of our modern dwelling places are absolutely dead from their birth. We might call them stillborn. They have never lived. They never express a warmth of heart. They have not that characteristic which, when we see them and approach them, seems to come and meet us halfway with welcoming and encircling arms. They never move towards us. We have to get up to them, and when we have got to them they have not a whisper of welcome to give to us. We enter their doors and we get no inspiration, no happiness, and no spiritual comfort from their companionship Now these old cottages, scattered from one end of the country to the other, give one a spirit of companionship, co-operation and happiness. We must not allow those expressions of the home spirit of our ancestors to pass altogether out of our experience. We must not allow ourselves to be left with the dead bricks which serve no purpose except to afford us a shelter from the winter's cold and protection from the summer sun. That is not a house. That is a hutch, or something else of the same kind, something that we express by "it." There is no man who is

*The Report will be found printed on pages 459-470

happy, and there is no man who has a chance of developing really everything that is in himself, if his home appeals to him as being something of the neuter gender It must be something that is part and parcel of his own individuality.

Of course, there are a great many issues involved in this. I can remember, and I think my friend Mr. Chesterton will certainly remember, that delightful and penetrating pamphlet by William Morris called "Useful Work versus Useless Toil." There are far too many of our homes built to-day, and being built, not by useful work but by useless toil. Therefore those of us who are here this afternoon, and those outside who share our sentiments in this respect, really are upholding an ideal, both artistic and moral, of work itself. The men who built these cottages never could have produced them if their muscles only had been exercised in their creation. They have been produced by a combination of muscular and heart service; and so long as we appreciate them, and so long as we vindicate their existence, and so long as we strive and toil for a continuance of their existence, whatever our intellectual convictions may be, our moral convictions must always predicate this—that heart and hand must go to the production of everything that enters as an element into home life

There is one other observation I would venture to make, and claim your indulgence for making, before I ask Mr. Chesterton to follow me, and it is this. As this nation grows older we will find more and more the necessity of keeping sanctuaries for the human foot and human mind. We talk about bird sanctuaries, sanctuaries for flora and sanctuaries for fauna These are excellent. But are we going to forget the even greater necessity of maintaining sanctuaries for ourselves? And if the sanctuary which is to be preserved for human beings is to be as rich as it ought to be, and as it can be, it must have something in it which is human, something which expresses the joy, the adoration and the contentment of the striving and aspiring human soul Therefore, there can be no sort of holy of holies in those sanctuaries better than the work of man's hands exerted for the purpose of building a home with results such as we see in some of the most beautiful, the quietest and the most reverent of these ancient cottages that unfortunately are so fast going to decay.

I am sure many of you have experienced the pleasure that I have had of a day when perhaps you have been trudging far and fast over delightfully inspiring moorland; and when the sun begins to set and the light from it is colouring with wonderful pathos the sky, you come to the bend when the road descends, and first of all you detect over the shoulder of a rising ground a blue smoke; and as you go down the winding road you are received, as it were, into the arms of a quiet peaceful settlement of thatched cottages. It seems as though somebody had been wandering and wandering and wandering for generation and generation and age and age, and had at last found rest in this little nook that had been waiting there for years and years to receive you as the only pilgrim.

We must not allow those places and those experiences to become absolutely impossible for our sons and our grandsons. I am not going only to appeal to you as men and women of taste, and men and women of good sentiment, but it is your duty as citizens, it is your duty as fathers and mothers, to see to it that those gloriously rich moments through which we have lived, those gloriously rich experiences that we have had at the end of those great days, shall still be a possibility to the young men and the young maidens who are going to fill our places when we are no longer here.

I, therefore, formally move that the Report should be adopted.

MR. G. K. CHESTERTON:—Mr Chairman, Ladies and Gentlemen. You, Sir, have said in a double sense, and with more truth than you knew that in this matter I am to follow you. I do not think there is anything really which can be at all adequately added to what Mr MacDonald has said so eloquently and so truly about the essential ethics and æsthetics of this question. I am driven back upon what is for me an incongruous and almost ghastly role, namely, that of attempting to be, in the presence of the distinguished leader of the Labour Party, a practical politician. At least, I am only going to say a few words on another aspect of the whole matter, because I feel that Mr. MacDonald has really said all that we want said upon the most serious aspect of it.

What is taking place in the countryside to-day is, to my mind, something more extraordinary than has ever happened in all the revolutions of the world. It is most extraordinary, because it is for the first time a revolution which is also a contradiction. It is like something out of *Alice in Wonderland* It is a logical inconsistency incarnate, because what you see is that the country is being ruined by people who like the country All sorts of wild and extraordinary movements and changes have passed across this planet in the course of history But men were not spreading and destroying the religion of Mohammed at the same time Men were not at once spreading the principles of the French Revolution, and also contradicting and denying them There has been a great rush of men to build medieval cathedrals. There has been a great rush of men to destroy them and smash the images in them God forbid that in this impartial atmosphere I should betray for a moment which of those two religious movements I consider the more valuable. Anyhow, it was not the same people who built the cathedrals and smashed the cathedrals But it is the same people who pursue the country and ruin the country. You have perpetually a number of uninstructed, ill-educated, but rightly inspired people pouring out from the detestable industrial cities and trying to live something more like the ancient and healthy life of man, with the unfortunate result that they carry out with them all the most detestable characteristics of the detestable civilisation from which they flee It is a comic, but also a tragic, and even a pathetic spectacle, and of course it is only too easy to be cheaply superior about it and to talk about the culture of Upper Tooting, and so on, spreading over the world Personally, I do not mind what I call the culture of Tooting as long as it is unconscious and sincere I prefer Lower Tooting to Upper Tooting But it is the actual practical fact of the situation that when the people of Tooting rush out, let us say to anywhere you like--Tenbury or Tetbury, two places in the West Country which I always confuse together because I have a cousin living in each when the inhabitants of Tooting rush out to Tetbury they immediately begin to try and make Tetbury or Tenbury, as the case may be, as much like Tooting as possible That is the real tragedy and the real farce of the whole situation, and it is very difficult to say how it is to be stopped There are two ends at which you can begin. If you are a great idealist and evangelist you can attempt the conversion of Tooting If, on the other hand, you are a local patriot you can, of course, die defending the road to Tenbury or Tetbury. It is probable, I think, that the real solution of that problem, which is the root problem of the whole thing, lies in the fact of the neglect and decline of agriculture. When people lived in Tenbury and Tetbury, prosperously and privately, and when they had to live on the land and by the land, they built their own houses suitable to the land and to the landscape. But when people go there simply as tourists, as trippers, as horrible people seeing views or going to beauty spots, they lack that inner creative impulse out of the earth which makes man create anything which is in the image of its origin and its significance.

I remember, for instance, a friend of mine who lives in Sussex in an old house. It was originally quite a small cottage—I believe a village shop. It still has the sort of fossil remains of the counter and of the places where the grocer's goods were piled on shelves. I remember looking out of the window of that cottage and pointing out to my friend that the window formed an exact frame, like the frame of a picture in the Royal Academy (if in so artistic an assembly I may mention such a place!)—the window formed a frame for the low, largely-spreading branches of a tree immediately opposite. If you had painted that thing as a picture and designed it for a frame, you would have made the window in that way. And if you examined carefully, you saw that the whole character, not of Sussex, but of that particular corner of Sussex—which is a corner of heavy land with low spreading trees, and not the high downs and the bare part of Sussex—you would see that the whole architecture of that little house, which was never intended for anything but a cottage or a shop, quite unconsciously followed the lines of the landscape. Had it been on the high downs above the sea, it would have been built differently. That is the art of architecture—the ancient and inspired art of a sort of frozen poetry in stone and clay—and people did it unconsciously, just as they sung songs unconsciously, just as they created great epics in the morning of the world unconsciously. We cannot do that now apparently. At any rate, we cannot do it until our society has been established on a considerably more healthy basis, particularly our agricultural civilisation; but we can say, if this wild, contradictory, extravagant movement is going on whereby people are perpetually destroying the very thing they seek, whereby people are to be perpetually rushing after a thing and killing it as they rush—we can at least say "Look here, here is a definite creation of man made under more normal, more dignified and more sane social conditions. It is like a Greek temple surviving in an age of barbarians. You shall not touch it. This belongs to the history of humanity. This is a human and a permanent thing. This was built by man for men living off the earth, as men have always lived and ought to live. It shall not be interfered with."

That, I take it, is the simple object of this Society. It is not, I take it, merely a Society of æsthetics. We are not running after beauty spots or pretty views. You defend the old cottage not because, viewed from a certain angle, somebody can make a beautiful water colour sketch of it, but because, as compared with a bungalow put up by a fool who spoils the very place that he admires, it is a sensible, solid, practical, utilitarian object. A man comes and builds a bungalow, another man comes and builds a bungalow at a totally different angle to it. A third man comes and builds another, and whole districts of the countryside are thus covered with a meaningless, criss-cross of lines which do not make a street or a village or a hamlet or any recognisable human thing—they make a litter.

In the midst of all these things stands the old human English cottage. God knows it had vices enough, and the system to which it belonged had vices enough. I for one have never defended the vices of the old English landlord system—no more than the Chairman would,—but it was the creation of a living human historical thing. It was built by people who lived on the land for people who lived on the land, and whatever else is allowed to destroy it, it must not be destroyed by people who do not know what they themselves want, and who destroy what they themselves seek.

Sir Charles Wakefield, Bt., C.B.E.:—The privilege which has been accorded to me this afternoon reminds me that I had the pleasure of assisting at the birth of the Fund for the Preservation of Ancient Cottages. Sir Frank Baines, to whose

inspiration we owe so much, launched the idea at the meeting of the Royal Society of Arts over which I had the honour of presiding. From that small beginning arose a fund which has already more than justified its existence.

There is little that need be said by me after the eloquent speeches to which we have just listened on behalf of this work. I can assure you, as far as I am concerned, that it will continue to have my practical support. As one who loves the peaceful beauty of our countryside, I rejoice that an organised effort is now being made to preserve some of the humble but very real wayside beauty of our lanes and villages.

I want particularly to commend both the aims of the work itself and the method which has been adopted in more than one case. The idea of advancing sufficient from the central fund to save by purchase some particularly choice old cottage, and then initiating a local effort to make a permanent endowment possible, is in my opinion most excellent. It gives permanent value to any monetary support which sympathisers are moved to give to the Fund. It is undoubtedly the right way to administer this Fund wherever circumstances make it possible. If those present this afternoon will only report this aspect of the Society's work to their business friends, I am sure they will obtain fresh support from those who like to see good work well and wisely done

MR. H. AVRAY TIPPING, F.S.A. —Mr. Chairman, Ladies and Gentlemen. Certainly after such admirable speeches as have been made by Mr MacDonald and Mr. Chesterton I am not going in for the "useless toil" of making another speech. I merely want to make what I will call, and what I hope is, a practical suggestion. What ought to be our work after two years of pioneering? I think we ought to begin to work now in rather a larger manner. We are all under the influence nowadays of the word "big." Everything has to be done on a big scale—mass production, huge combines and monstrous advertisements. It is quite true that what we are working for is not something big, but for the preservation of something that is little—the modest and charming homes of the working men of the England of the past. Yet, at the same time, living as we do in these days, I fancy that the infinitely little has got to lie side by side with the infinitely big. I do not think we shall be able to carry this movement very far unless we do something in rather a big manner. It is quite right to begin in a humble and small way, to feel our way, to gain experience, to till the ground intensively so that we may know thoroughly what we are doing. That is what we have been busy upon for two years now, and I am glad that the Chairman considers that we have laboured very well and successfully. Certainly we have learned a good deal if we have not done so very much. We have saved a row of cottages in Sussex. We are saving a still larger row of admirable cottages in Gloucestershire. That was a good thing to do, and has taught us not only to do it but how to do more beyond it. It has taught us that, without any very great plunging into our own somewhat modest capital as it is at present, we can interest neighbours and local bodies so that these cottages can be saved and maintained largely by local money and by local effort. That is excellent. The question is, have we not now to go further? Have we not now to tackle not so much the problem of a little strip of a village, but a complete and entire village? What I should like this scheme for the saving of old cottages to say is "We are determined to try our hands on a large scale; we are determined to try our hands on a complete village." That is a big thing to do. I hope, having reached the age of more than discretion, that I am not rash; and I hope when I ask you to make a plunge you will see that it is a plunge into prepared waters—waters that we have been preparing for the last two years

and of which we have experience. That we have gained experience, that we have now a reputation, is surely clear by the fact that for our Annual Meetings we can obtain as Chairmen Prime Ministers and ex-Prime Ministers. Surely that gives us the right to come forward and say " We have gained our experience. We have begun well. We wish to go forward to something larger." But I think unless we appeal to those on both sides of the Atlantic who are in the position to endow our efforts with adequate funds we shall not succeed. I should say " Be brave. Let us find one of these really delightful villages and do our duty by it." I believe if you purchased it you would get support on both sides of the Atlantic. I believe in that way, properly advertised—I hope with advertisements that will not be monstrous, but by means of some charming pamphlet in which are photographs of the existing delightful village whose charms are perhaps under the bushel, which are perhaps a little decayed but which are full of latent possibility for beauty - and if, in addition, you asked a competent artist, a man of feeling, to depict something of the appearance which that village would obtain under your hands—I think then you would get very large support. You would be able to show your supporters one of these perfect villages -one of these villages which appeal not merely to the æsthetic brain but to the plain man's heart. You will be able to show them that there are, and there will be for ourselves and for those after us, some small but charming earthly paradises.

SIR ARNOLD WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O.: -I have been asked, as a member of the Advisory Committee of this Fund, to say a few words in support of this motion, which has been proposed by Mr. Ramsay MacDonald with such sincerity and eloquence and supported by Mr. Chesterton with his accustomed humour and grace. In this matter, we are all Mr. Ramsay MacDonald's constituents; among the cottages we seek to preserve, is many " a low white house, where dwelt the South land man." I, who have carried " The Ballad of the White Horse " in my pocket all over South America, should have known Mr. Chesterton to be an ally even had he not spoken. Two years ago this Fund was launched, with the approbation of Thomas Hardy, with the support of Mr. Baldwin and with the endorsement of the Duke of Connaught. No words of mine are needed to commend a movement initiated under such auspices and backed with such authority, but as a lover of England, which I left when I was 18 and to which I have only recently returned, I appeal to all to make the existence of this Fund known, not only to residents, but to the visitor from English speaking lands whose piety brings him to our shore.

Whilst we take off our coat to the future, we must not forbear to raise our hat to the past—to show the public how they may best perform the latter duty is peculiarly the province of this Fund. Our cousins from overseas are wont to make a pilgrimage to the homes and graves of their forebears and to seek to learn something of their manner of life. In cottages, along our sequestered lanes, the visitor can see how his forefathers fared, and what they held dear: here he may reflect on the immense labour of past generations that has gone to make the countryside; here he may see " the rock from which we were hewn and the pit from which we were digged." Such visitors will not be backward in helping this Fund if the appeal should reach their ears.

If one thing more than another distinguishes the history of this country from that of others not so blessed as we, it is surely continuity of tradition and custom. Other countries change the external form of their institutions, but retain only too often much of the bad old spirit. Our way is to keep our outward forms, but to change, for the better, the spirit that informs them. In this perhaps lies our

strength, and here perhaps is the secret of our unity. The cottages which it is the object of this Fund to preserve are indispensable and essential links with the past. It has been my good fortune to travel in many countries, new as well as old, and no single thing has struck me more than the moral and spiritual handicap under which peoples labour who have no tangible memorials of earlier ages: Mr. Ramsay MacDonald was recently in the U.S.A. and will understand, as will many of you, what I mean. To conserve such links is not less incumbent on us than to preserve the written records of our race, for these ancient dwellings reflect the outlook of their owners, not less surely than the furniture and internal arrangements of a modern house reflect the taste of its occupants. For just as most of us can arrange the interior of our houses to suit ourselves, so did our forefathers with their own hands and to their own plans build these houses, on sites of their choosing, "to live in" as Bacon says, "not to look at."

It is an elementary principle of art that a building, the form of which expresses the manner of its construction, is greater and richer than a building which fails to do so. No class of human dwelling place so completely conforms to this principle as do these cottages. Their beauty is not skin-deep: it is in their bones; in each and all of them there is an obvious link between the form and the material.

We do not seek to create show-places or museums—dead shells abandoned by their inhabitants, or occupied by week-enders, the human equivalent of hermit-crabs. Our object is to secure that these cottages are in every respect as comfortable and sanitary as modern houses, and that they are tenanted by agricultural workers, than whom no one in England better deserves a good home or knows better how to use one. "The rolling English drunkard," says Mr. Chesterton, "made the rolling English road," but he was sober when he made the cottages which we seek to preserve. After all, it is from such homes that the vast majority of us come—not more than four or five generations back, and such homes saw the birth of our greatest men. Preserving them, whilst working in other directions for better housing, we may help to give effect to Milton's appeal 300 years ago to his countrymen:—

"Let not England forget her precedence of teaching nations how to live."

May I in conclusion be allowed to quote another of my favourite poets, T. E. Brown:

Dear Countrymen, whate'er is left to us
Of Ancient heritage—
Of manners, speech, of humours, polity
The limited horizon of our stage—
Old love, hope, fear,
All this I fain would fix upon the page;
That so the coming age,
Lost in the Empire's mass,
Yet haply longing for their fathers, here
May see, as in a glass,
What they held dear—
May say, "'Twas thus and thus
They lived"; and, as the time-flood onward rolls,
Secure an anchor for their Keltic souls.

Sir Fabian Ware, K.C.V.O., K.B.E., C.B., C.M.G.:—As I listened to Mr. Chesterton I felt that the only role which was left for me to fill—as he had taken that of the practical politician—was that of the practical man. I am afraid in the time at my disposal I shall not be able to fill that role very efficiently, but I just want to explain

to you why I have been asked to speak this afternoon. I am at present Chairman of the Gloucestershire Rural Preservation Committee, which is extremely interested in what you are doing with regard to Arlington Row. My Committee has not been able to take any active part in the work you are doing, and I want quite briefly to tell you why, because I think, as the practical man, that that has a real bearing on the admirable suggestion which was made by Mr. Tipping with regard to expanding your work to a whole village. The Gloucestershire Rural Preservation Committee, which is working in close association with the Council for the Preservation of Rural England, is engaged in a desperate fight against the invasion of the countryside by new and totally unsuitable houses. We have decided that that danger is so great and so pressing that we must concentrate on that and on that alone. We have deliberately come to the conclusion that we have no powers which enable us to prevent that invasion as we should wish to. I cannot in the short time at my disposal give you any idea of the rate of the progress in the erection of pink asbestos roofed bungalows, or as to how village after village has gone for the next generation, or how bits of unequalled beauty are still left, but with the tide of ugliness lapping at their very edge. In the presence of Mr. Ramsay MacDonald I want to say that that situation has arisen entirely inexcusably, because no Statesman in this country has had during the last fifteen years the determination to say to these people, "You shall not." They tell us that that is interfering with individual rights I may go into a new store in one of the most beautiful parts of the Cotswolds, and after a certain hour I may shout until the red corrugated roof rattles asking for an ounce of tobacco, and the reply is "You shall not." If I ask that we may do something to prevent a similar building being erected, I am told that that is interfering with individual liberties. I was recently in Alsace in that part of Alsace which had been in German occupation for forty years. It has now been handed back. I saw there the only villages which in my experience in any way correspond to our Cotswold villages, and I saw that they had been preserved by the Germans for forty years as beautiful as when they first took them over not denying the need of progress, but adapted by the best architectural advice to the old and still beautiful villages. It is not a pleasant thought, ladies and gentlemen, that, but for the Grace of God, the Germans would now be preserving our Cotswold villages for us.

At present we can do little more than educate public opinion, as legal powers to do anything practical are wanting. We are, of course, busily searching into Acts of Parliament for an illusory solution of our difficulties with an optimism which neither Westminster nor Whitehall will discourage Nevertheless, we know that we can get no further on that line until we force this Government or its successor to give us the powers we desire. Meanwhile you are doing something practical. You are actually preserving from destruction some of these beautiful cottages. I need say no more about them Mr. Ramsay MacDonald has described them to you. I will only say this—that I do wish, before you carry out your greater scheme, which has my heartfelt sympathy and support, you will remember that as well as cottages there are beautiful barns in our Cotswold country. I ask you to remember, too, that within the last twelve months the stone tiles from two of those most beautiful barns have been removed to America to roof churches in Boston, and they have been replaced by red corrugated iron. The tragedy speaks for itself.

I want you to know that the Gloucestershire Rural Preservation Committee is heart and soul behind you in the campaign which you are carrying on. We hope that the fact that Mr. Ramsay MacDonald is in the Chair at this meeting will result in our being placed, by the bestowal of those powers which we mean to have,

in the position of giving you greater help by preventing that beautiful Arlington Row, when you have restored it, from being utterly spoiled by the setting being destroyed—as it would be by the erection of bungalows and scarlet villas around it

One last word. We have in Gloucestershire some of the very best architects in England. You have chosen for the work you are carrying out one of the best of those architects, Mr. Norman Jewson. Your Committee knows with what loving care and devotion Mr. Norman Jewson is carrying out this work. I hope that it will never be able to be said that through lack of funds he was not allowed to make the job that he wishes to make of this undertaking which you have given him.

THE CHAIRMAN:—It is now my duty to put to you the resolution which I have moved—that you adopt the Report, which has been circulated, of the Fund for the Preservation of Ancient Cottages for this year.

The resolution was put and carried unanimously.

SIR GEORGE SUTTON, Bt. (Chairman of the Council):—Mr. Chairman, ladies and gentlemen, it is my pleasing duty to ask you to give a vote of thanks to Mr Ramsay MacDonald for presiding here to-day—not only for presiding and carrying out the functions of the Chair, but for having given us such a beautiful address. We have been very fortunate to-day in all our speakers, especially in the Chairman I do not think I exaggerate when I call Mr. Ramsay MacDonald's address a poem

Before I put the vote of thanks there is just one thing I want to say, and I say it as Chairman of the Royal Society of Arts. We want more subscriptions given to this movement. We have done very well. You who read the Report will see that in two years a good deal of work has been done, and we have many subscribers But there is nothing that can be done now in the world, it seems to me, without money, and we have got to get it. We cannot expect to find the money to compete with those people on the other side of the Atlantic who come here and buy many of the beautiful things we have here. If, however, we have a large number of subscribers, and if every subscriber becomes an active supporter of this movement we can do much. And it is not the Society's money only that aids the objects we have in view. Such is the case of Constable's Flatford Mill. I understand that those buildings were secured to the nation by the direct influence of this movement.

Ladies and gentlemen, the time is late and I will not detain you by saying some of the things I would like to say about this movement. I will merely ask you to pass a vote of thanks to Mr. Ramsay MacDonald for his kindness in giving us some of his precious time in order to preside here to-day.

The vote of thanks was put and carried unanimously.

THE CHAIRMAN:—I am very much obliged to you, ladies and gentlemen, for the way in which you have responded to Sir George Sutton's request. May I say that I would like very much if you would support the appeal of his for more money? It is money that makes the mare go. Fortunately or unfortunately, that is the fact, and I think this Fund ought to be supported even more liberally than it has been. Then might I ask you to help as much as you possibly can the sisterly effort which is now being made by showing those horrors which have taken place in our countryside by the photographic exhibition which is now open at the Royal Institute of British Architects in Conduit Street? We really must put our backs into this preservation if we are going to succeed, and I do hope by supporting this Fund by money and by patronising the admirable, but horrifying exhibition which I have mentioned, you will encourage the preservation of some of those delightful inheritances which we have had from our forebears in this country.

The meeting then terminated.

FUND FOR THE PRESERVATION OF ANCIENT COTTAGES.

FIRST ANNUAL REPORT.

ADVISORY COMMITTEE.

NOMINATED BY THE COUNCIL OF THE ROYAL SOCIETY OF ARTS.

*P. MORLEY HORDER, Esq., F.S.A., *Chairman.*
*SIR GEORGE SUTTON, Bt. (*Chairman of the Council*).
Sir THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
*E. J. HORNIMAN, Esq., J.P.
*JAMES H. HYDE, Esq.
*BASIL OLIVER, Esq., F.R.I.B.A
*ALFRED H. POWELL, Esq.
*H. AVRAY TIPPING, Esq., F.S.A.
*Lt.-Col. Sir ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O.

NOMINATED BY OTHER BODIES.

Ancient Monuments Society ...	JOHN SWARBRICK, Esq., F.R.I.B.A.
Association of Women House Property Managers	Miss A. CHURTON.
Auctioneers' and Estate Agents' Institute	Sir WILLIAM WELLS, F.S.A.
The Worshipful Company of Carpenters	H. WESTBURY PRESTON, Esq.
Commons and Footpaths Preservation Society	STENTON COVINGTON, Esq.
Council for the Preservation of Rural England	E. GUY DAWBER, Esq., A.R.A., P.P.R.I.B A
Country Gentlemen's Association, Ltd.	F. H. PURCHAS, Esq.
County Councils Association ...	Sir HENRY FAIRFAX-LUCY, Bt.
Cyclists' Touring Club ...	G. HERBERT STANCER, Esq.
English Speaking Union ...	Dr. J. F. MUIRHEAD.
Folk Lore Society	Dr. M. GASTER.
Garden Cities and Town Planning Association	A. T. PIKE, Esq.
Guild of St. George	A. FARQUHARSON, Esq.
Homeland Association ...	PRESCOTT ROW, Esq.
Institution of Municipal and County Engineers ...	E. WILLIS, Esq.
Ministry of Health ...	*RAYMOND UNWIN, Esq., F.R.I.B.A.

National Council of Social Service	A. C. RICHMOND, Esq.
National Gallery, Trafalgar Square	C. H. COLLINS BAKER, Esq.
National Trust ...	*NIGEL BOND, ESQ., O.B.E.
Royal Academy of Arts ...	Sir GILES GILBERT SCOTT, R.A., F.R.I.B.A.
Royal Archaeological Institute	WALTER H. GODFREY, Esq., F.S.A., F.R.I.B.A.
Royal Automobile Club ...	ARTHUR J. DAVIS, Esq., F.R.I.B.A.
Royal Historical Society ...	HAROLD SANDS, Esq., F.S.A.
Royal Institute of British Architects	OSWALD P. MILNE, Esq., F.R.I.B.A.
Royal Photographic Society ...	THOMAS H. B. SCOTT, Esq., F.R.P.S.
Rural Industries Bureau ...	Lieut.-Col. W. B. LITTLE, D.S.O., M.C.
Scapa Society	
Society for the Protection of Ancient Buildings	*A. R. POWYS, Esq.
Surveyors' Institution ...	PERCIVAL F. TUCKETT, Esq., F.S.I.
Town Planning Institute ...	E. G. ALLEN, Esq., F.R.I.B.A.
Victoria and Albert Museum ...	R. P. BEDFORD, Esq.

* Member of the Executive Committee The Executive Committee was appointed at the first meeting of the Advisory Committee on June 15th, 1927

The proposal to institute a Fund for the special purpose of preserving our ancient cottages was first put forward by Sir Frank Baines in a paper which he read before the Society on May 6th, 1926.* While there are various public bodies charged with the duty of looking after our Ancient Monuments, cathedrals, etc., the unfortunate cottage has been left to the mercy of chance, with the deplorable result that many of the most beautiful specimens have been allowed to disappear. The need of preserving those that remain is, therefore, all the greater. In the avalanche of sham-tiled bungalows and houses good neither to live in nor look on that has overwhelmed the country, it is essential that we should save as many as possible of those quiet, peaceful and harmonious cottage homes if we would preserve any vestige of what was once the charm of our English countryside.

The plea put forward by Sir Frank Baines was so convincing that the Council of the Royal Society of Arts at once decided to adopt his suggestion. Accordingly a conference was called on January 26th, 1927, when the Prime Minister presided, and moved the following resolution :—

> "That this meeting, called to consider the best means of preserving the ancient cottage architecture of this country, declares its warm support of the movement started by the Royal Society of Arts, and signifies its intention

* Copies of the paper, which was printed in the *Journal of the Royal Society of Arts* June 11th, 1926, can be obtained on application to the Secretary.

to assist in the establishment of a substantial fund for application on the broadest national lines in furtherance of this movement."

The resolution was supported by the Earl of Crawford, the Speaker of the House of Commons, and Sir Alfred Mond (now Lord Melchett), and was unanimously adopted. At the close of the meeting it was reported that up to that date £1,855 had been promised.†

The Prime Minister's Appeal.

Shortly after the conference an illustrated pamphlet was issued containing an appeal on behalf of the Fund by the Prime Minister, and a note by the late Thomas Hardy. About 12,000 copies of this have been circulated, and very wide publicity has been given both to the conference and the pamphlet by the Press, to whom the Council and all those concerned in promoting the movement desire to express their grateful acknowledgments.

Luncheon at the Carpenters' Hall.

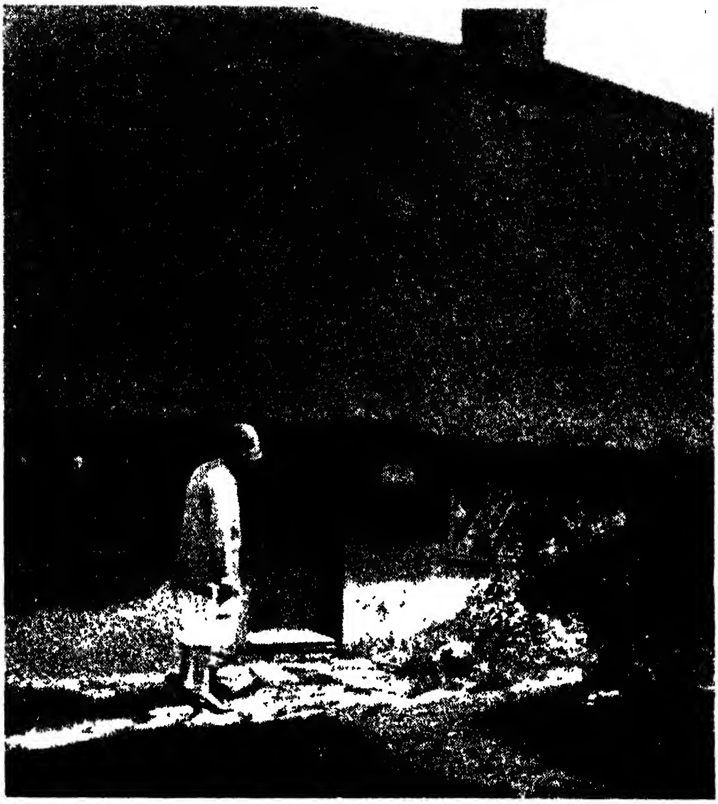
On March 25th, 1927, a luncheon in aid of the Fund was given by the Master and Wardens of the Worshipful Company of Carpenters in their Hall in Throgmorton Avenue. Mr. H. Westbury Preston, the Master, in proposing the toast of "Success to the Fund," said that the movement initiated by the Royal Society of Arts was specially welcomed by the Carpenters' Company, because the beautiful old cottages which they were trying to preserve were largely the work of carpenters. The toast, which was supported by Sir Rowland Blades, Bt., M.P. (Lord Mayor of London), Sir William Pender, Bt., G.B.E., Lieut.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., Sir Howell J. Williams, D.L., and Sir Banister Fletcher, Vice-President, R.I.B.A., was replied to by Sir Frank Baines, K.C.V.O., C.B.E. At the conclusion of the proceedings, Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, expressed the thanks of the Royal Society of Arts to the Master and Wardens of the Worshipful Company of Carpenters for the valuable support which they were giving to the movement.

As a result of the luncheon the sum of £949 14 6 has been contributed to the Fund through the Carpenters' Company.

Appointment of Advisory and Executive Committees.

In February, 1927, the Council decided to appoint a large Advisory Committee containing representatives of the principal institutions and societies likely to be interested in the objects of the Fund, and a smaller Executive Committee. A list of these is printed at the head of this report. The Advisory Committee met for the first time in June, 1927, and the Executive Committee has met at fairly frequent intervals since then.

† A full report of the meeting was published in the *Journal of the Royal Society of Arts*, February 11th, 1927. Copies can be obtained from the Secretary.



CHARLES LAMB'S COTTAGE, "BUTTONSNAP"
Recently handed over to the Society.

WORK DONE

Charles Lamb's Cottage

Shortly after the publication of the Prime Minister's Appeal, Mrs. M. Greg, of Coles, Buntingford, Herts., offered to hand over to the Society the cottage known as "Buttonsnap," West Mill Green, which was at one time the property of Charles Lamb.

The cottage is referred to in Elia's Essay, "My First Play," in these words :

> "F. (my godfather) was the most gentlemanly of oilmen . . . . . by his testamentary beneficence I came into possession of the only landed property which I could ever call my own—situate near the road-way village of pleasant Puckeridge, in Hertfordshire. When I journeyed down to take possession, and planted my foot on my own ground, the stately habits of the donor descended upon me, and I strode (shall I confess the vanity ?) with larger paces over my allotment of three-quarters of an acre, with its commodious mansion in the midst, with the feeling of an English freeholder that all betwixt sky

and centre was my own. The estate has passed into more prudent hands, and nothing but an agrarian can restore it."

The "commodious mansion" was a four-roomed cottage, and the door is so low that one has to duck one's head as one enters it. Local tradition has it that the name of the cottage, "Buttonsnap," is due to the fact that people, taken by surprise, duck so suddenly that the buttons snap from their trousers, but the etymologists may have something to say to this.

The cottage passed out of Lamb's possession in 1815, when he wrote to his tenant, Mr. William Sargus, as follows:—

MR. SARGUS,

This is to give you notice that I have parted with the cottage to Mr. Grig, jun., to whom you will pay rent from Michaelmas last. The rent that was due at Michaelmas I do not wish you to pay me. I forgive it you, as you may have been at some expences in repairs.

Yours,

CH. LAMB.

Inner Temple Lane,
London.
23 Feb., 1815.

The cottage is of a type very common in Hertfordshire and does not possess any special features of architectural or antiquarian interest; but in view of its association with the gentle Elia, the Council decided to accept Mrs. Greg's offer, and a small local committee has been formed under the chairmanship of Sir Arnold Wilson, who are charged with the duty of looking after the property. The cottage has been put into a good state of repair, and has been leased for a period of years to reliable tenants who are under obligation to maintain it and its surroundings in a proper state of preservation.

THOMAS À BECKET COTTAGES, WEST TARRING.

In September, 1927, the three well-known Thomas à Becket Cottages at West Tarring, near Worthing, were put up to auction. Shortly before the sale it was ascertained that attempts to buy the cottages would be made by two bidders, one with a view to demolishing them for the material which they contained, the other with a view to fitting them with modern plate-glass shop-windows.

It hardly seems credible that schemes of this sort could have been contemplated. The cottages are of quite extraordinary beauty and interest. The roofs are covered with Horsham slabs, and these, together with the oak beams, are in perfect preservation. The interiors are also in an excellent state, and the whole group forms a unique example of early fifteenth-century architecture.

Thanks to the intervention of Mr. A. Mackenzie Ross, who resides near Worthing, aided by an advance of £600 from the Society's Fund for the

THOMAS À BECKET COTTAGES, WEST TARRING.
Recently saved by the Society.

Preservation of Ancient Cottages, sufficient money was temporarily raised to buy in the property, which was secured for £950. A public meeting was called by the Mayor of Worthing on November 3rd; Sir Frank Baines delivered an address on cottage architecture, and it was decided to start a local fund. The cottages have been handed over to the Sussex Archæological Trust, who will maintain them as dwelling houses.

It is very satisfactory to be able to add that of the £600 advanced by the Society, £540 has already been repaid.

Arlington Row, Bibury.

At the close of 1927 the owner of Arlington Row, Bibury, finding that he was no longer able to keep the eight cottages in proper repair, offered to hand them over for a small figure to the Royal Society of Arts, on condition that they should be put into proper order, that the rents should not be raised nor the present tenants disturbed. Bibury is one of the best known villages in the Cotswolds, and Arlington Row is perhaps the most beautiful group of cottages in Bibury, and the Committee, therefore, requested their architect, Mr. Norman Jewson, of Cirencester, to examine and report on the condition of the houses. The beautiful stone-slated roofs are in imminent danger of collapse and other repairs are necessary, the cost of which is estimated at

£1,000. As the rents are insufficient to defray the cost of maintenance it was thought advisable to aim at inaugurating a special fund of £500 for this purpose, and an appeal was issued in March last asking for £2,000, which will provide for the purchase of the eight cottages, the repairs immediately necessary, and also for a permanent repair fund. The Appeal was signed by Earl Beauchamp (Lord Lieutenant of the County of Gloucester), the Bishop of Gloucester, Earl Bathurst, Sir Gilbert Wills, Mr. Walter Tapper (President, Royal Institute of British Architects), Sir Philip Magnus (Chairman, Council of the Royal Society of Arts) and Sir Frank Baines (Chairman of the Fund for the Preservation of Ancient Cottages)

In response to this appeal the sum of £1,275 19s. 4d. has been received. Although this falls considerably short of the sum aimed at, the Council have decided to purchase the cottages and carry out the necessary repairs. In the meantime the subscription list remains open.

Smarden, Kent.

In August, 1927, the Society's attention was drawn to the sale of property at Smarden in Kent, and especially to a very authentic half-timbered house which was so typical of the period that rumours of its purchase for deportation were confirmed. A question was asked in the House of Commons by Sir Leslie Scott regarding this. The Society has watched this carefully and it hopes to report very shortly that it has been preserved and that the purchaser will place himself in the hands of the Society to advise as to its restoration.

Other Cases.

In addition to the cases already mentioned, a great many applications have been received from the owners of cottages for assistance to enable them to carry out necessary repairs which they themselves are unable to afford. When the Fund was started the Committee were hopeful that they might be able to consider such cases, as they would have liked to save every cottage with any pretence to interest or beauty; but it soon became evident that the state of the Fund would not permit them to indulge in wholesale preservation, and they came to the conclusion that it was advisable to concentrate their efforts on preserving specimens of outstanding merit. They would like to take this opportunity of stating, however, that their first year's experience shows that they could with advantage spend a hundred times the amount that has been placed at their disposal, and in this way they would not only be doing a great deal to preserve the beauty of the countryside, but they would be making a sound and lasting contribution to the solving of the housing problem.

The Society has before it proposals to assist in preserving interesting cottages in Stroud, Glos.; Suffolk; Kent; Hampshire and Oxfordshire. It was also approached by the Medical Officer of Health at Shrewsbury regarding a

[Photograph by W. Dennis Moss. Cirencester.

ARLINGTON ROW, BIBURY, GLOS.

considerable number of half-timbered cottages, which it was suggested were too derelict to remodel and which would in the ordinary course of things be condemned. The Chairman has visited the district and is dealing with a number of these and has advised that if certain works were undertaken they would make better and more roomy cottages than new ones, and that it is obviously in the interests of the district to keep these in existence. The attitude of the District Council of Shrewsbury is very encouraging and the Society felt it was its duty to give every possible assistance in the way of advice and is awaiting the development here with great interest.

The Society wishes to make it very clear that whilst it is anxious to preserve every bit of old beauty religiously, it realises that many old cottages have become so decrepit that it would be useless to keep them unless they can be made really healthy dwellings and unless the lighting, air content and sanitation can be made to conform to modern hygienic requirements for the men, women and children of to-day.

The building and planning of new houses and new residential areas is beyond the scope of the Society, but it is most anxious to encourage in any way possible the building of good new houses at rents which it is within the power of agricultural labourers to pay, and although opposed to riband development and ill-considered building schemes that conflict unnecessarily with the amenities of the countryside, it is far from desiring to oppose any housing schemes which are undertaken in the interests of public health and national welfare.

Flatford Mill and Willy Lott's Cottage.

Flatford Mill and Willy Lott's Cottage are indissolubly associated with the life and work of John Constable. In deference to the wish of his father he endeavoured to become a miller, and when about 18 years of age he spent some twelve months in the mill, trying to follow this trade. Fortunately for English art, however, his love of painting was irresistible and he went to London to study art; but throughout his life he remained devotedly attached to his native district; he returned repeatedly to Flatford, and the mill and its neighbourhood form the subjects of three or four of his most famous masterpieces.

In order to preserve this corner of Suffolk, hallowed by its association with one of the greatest of our landscape painters, Mr. T. R. Parkington, of Ipswich, has purchased Flatford Mill, the Mill House, and Willy Lott's Cottage. The property had fallen into extreme neglect, and Mr. Parkington, with the help and assistance of local antiquaries and others interested in the preservation of our cottage architecture, has carried out, at his own expense, the complete and adequate renovation and repair of the property. It may be interesting to mention that Mr. Parkington's action was the direct outcome of his hearing the appeal made by the Prime Minister in support of the movement at the Conference held at the Society's House on January 26th, 1927.

It is intended to use the property as a place of residence where artists may study landscape painting or to which art masters may take their pupils for holiday courses. The district abounds in interesting architecture, a number of the churches in the neighbourhood being particularly fine, and it is thought that students of architecture also could make it a centre of study.

Mr. Parkington has provided the place with appropriate furniture, and eventually about twenty bedrooms will be available for visitors.

The Possibility of Preserving a Complete Village of Exceptional Historic or Aesthetic Importance.

As a result of certain propaganda work undertaken by the Fund in the United States, and owing to various suggestions conveyed to members of the Committee by interested Americans, the Executive Committee is making an investigation into the possibility of considering the preservation of a complete English village of historic and æsthetic importance, which has fallen into neglect and decay. More than one village presents itself as suitable for a special undertaking, and the matter is under careful enquiry, with a view to seeing whether any developments are possible on these lines.

Photography Competition

The Royal Photographic Society has shown a great interest in the propaganda work of our Fund, and in the February number of that Journal they made an appeal for good photographs of cottage architecture to all members of the Royal Photographic Society and to the many thousands of photographers throughout the country who are members either of photographic clubs or local photographic societies affiliated to the Royal Photographic Society. They also organised a photography competition, the subject of the competition being the interiors and exteriors of cottages. The photographs were exhibited in the Gallery of the Royal Photographic Society, and any photographs submitted may, under the conditions of the competition, be retained for the purposes of the Fund. The Executive Committee expressed their grateful thanks to the Royal Photographic Society for the interest and the valuable assistance which they gave to the movement.

Publication of a Book on Cottages.

As a result of an enquiry on the part of certain members of the Executive Committee discussions have taken place with a well-known firm of publishers as to the possibility of bringing out a comprehensive volume dealing with ancient cottages from the structural, historical and æsthetic sides. After considerable discussion it has been decided that Mr. Basil Oliver, a member of the Committee, who has previously shown his interest and enthusiasm in, and knowledge of, the Cottage Architecture of this country, should undertake the preparation of the volume, which it is hoped will be

published in the early future under the title of "The Cottages of England."* The thanks of all concerned are due to Mr. Basil Oliver for undertaking this important work, which will help in bringing the subject before the general public and be the means of initiating further propaganda work with regard to the general problem of the preservation of our ancient cottages. It is hoped that supporters of the Fund will do what they can to secure the success of the publication by bringing the volume to the attention of any persons who might be interested in the subject

MEETING AT THE CARPENTERS' HALL.

With a view to making the movement better known The Worshipful Company of Carpenters invited the Members of the Society of Yorkshiremen in London to their Hall on March 31st, 1928, to hear a lecture by Sir Frank Baines, the guests being subsequently entertained to tea. The lecture was attended by a large audience. The Committee feel that the local patriotism in each county might be stimulated by lectures on the subject of local cottages, given in the large towns and illustrated by photographs. They would therefore welcome any suggestions for the giving of such lectures and would assist as far as possible in providing lecturers and slides.

RESIGNATION OF SIR FRANK BAINES.

The Committee have to record with deep regret that Sir Frank Baines has been compelled on the ground of ill-health to resign the chairmanship of the Advisory and Executive Committees Sir Frank originated the movement, and he threw himself into it with his customary whole-hearted vigour, and it is only on account of imperative medical orders that he has consented to give up the office.

Mr. P. Morley Horder, F.S.A., has been elected Chairman in his place.

FINANCE.

Up to the present moment the amount subscribed to the General Fund for the Preservation of Ancient Cottages is £5,414 9s. 2d., of which £64 10s. represents annual subscriptions, which are particularly welcome.

The Committee were extremely anxious to establish an invested fund in order that the movement for the Preservation of Ancient Cottages should be a permanent one. At the same time they felt that the public were more likely to support them if they saw some actual results, and it was, therefore, decided to invest £3,000, and keep the remainder in a fluid form so as to be available in case any particularly interesting or beautiful cottages should be suddenly threatened. In this way they were able to save the West Tarring Cottages, which otherwise would have been demolished. The Society advanced £600 towards their purchase, and the committee in charge of them have, as stated above, already repaid £540 of this.

*See the descriptive folder which has been inserted in the Report

In the case of Arlington Row, Bibury, it was decided to issue a special appeal for £2,000. The group of cottages is exceedingly well known. Bibury, which has been described by William Morris as "the loveliest village in England," is a show place, and the Committee felt certain that if it were known to be in danger, the public would be willing to subscribe the small amount that is necessary to save it.

The Royal Society of Arts have placed their office and staff at the service of the Fund, so that, apart from a small sum for extra clerical assistance, there have been no overhead charges.

OFFER FROM AN ANONYMOUS DONOR.

The Committee wish to invite attention to an offer which has recently been received from an anonymous benefactor, who has already contributed £500 to the Fund, to make a further contribution of 10 per cent. of all additional sums which may be received between January 1st and 31st December, 1929, from those who have given to the Fund from its commencement up to the date of the First Annual Meeting.

The amount already received is £5,414 9s. 2d. so that the anonymous donor is willing to more than double his gift of £500, and is anxious for as many as possible to assist to raise the total to at least £10,000. The income derived from such an amount would permit of the work of the Fund being proceeded with to a modest extent with no expenditure of capital, except in special cases, but a much larger sum could be very usefully administered.

It is hoped that many of those who have already subscribed may be willing to increase or double their contributions, in order to enable the Fund to reap the greatest possible benefit from this generous offer.

Contributions, which should be made payable to the Royal Society of Arts, and crossed "Messrs. Coutts & Co., Fund for the Preservation of Ancient Cottages," should be addressed to the Secretary, Royal Society of Arts, John Street, Adelphi, London, W.C.2.

FINANCIAL STATEMENT TO DECEMBER 31ST, 1928.

Expenditure.	£	s.	d.	*Receipts.*	£	s.	d.
Invested	3,000	0	0	Subscriptions* to General Fund	5,414	9	2
Loan to secure Thomas à Becket Cottages, near Worthing, £600 less £540 repaid	60	0	0	Interest on Investments ..	113	6	10
Printing, Postage, extra clerical work, etc. ..	405	11	10	Hampstead Garden Suburb Stock	55	0	0
Balance in hand	2,117	4	2				
	£5,582	16	0		£5,582	16	0

ARLINGTON ROW, BIBURY, FUND.

	£	s.	d.		£	s.	d.
Printing, Postage, etc. ..	11	2	6	Subscriptions*	1,175	19	4
Balance in hand ..	1,164	16	10				
	£1,175	19	4		£1,175	19	4

* The lists of subscriptions have been omitted from the *Journal* owing to lack of space, but are included in a separately printed edition of the Report which may be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

NOTES ON BOOKS.

Outlines of Paint Technology. Based on "Hurst's Painters' Colours, Oils, and Varnishes." By Noel Heaton. With frontispiece, and 109 illustrations in the text. London: Charles Griffin & Company, Limited. 24*s*. net.

Mr. Heaton had a difficult task in prospect when he undertook the modernisation of the seventh edition of the late Mr. Hurst's textbook, so as to make it quite satisfactorily representative of the almost overwhelming mass of new methods; and this without neglecting the old methods, which are still of high commercial importance. The problem has been solved by a careful re writing of the old matter, so as to gain a maximum of space, and the result is a work which deals fully and satisfactorily with both old and new; this, moreover, without unduly increasing the size of the book.

In the first thirteen pages, after a concise but sufficiently illustrated account of scientific fundamentals relating to light and colour, there follows practical instruction as to instruments by which colour measurements can be made. We have, in the premier aspect, Mr. Guild's colorimeter (Fig. 4, p. 8) a delicate and complex construction from the optical workshops of Hilger, Ltd. This device gives a synoptical view of a coloured surface and its fundamentals, the author telling us that "the operator, looking through the telescope, sees the colour to be measured side by side with a patch of light composed of the three primaries." The operator can then adjust the mechanism "until the light matches the sample." This elaborate construction by Hilger, although ideal where proper laboratory care is available, must in many paint works be made to cede to a less complex device. First among these is the portable and convenient Tintometer of Lovibond, pp. 8-9, and Figs. 5-6, in which the observer gets a view of the colour to be measured and of a like tint as obtained by arranging standardised glass colour screens. Lovibond's tintometer has stood the test of about half a century in our workplaces, and it still leads. Next, on p. 10, we find descriptions of comparable devices by Ives, Bawtree and Jones, this last making the match with three wedge-like films of tinted gelatine Finally, on p 11, the old rub-down method on a glass plate or on a white surface is described, and we learn how to use this method to the best advantage: one aid being a standard lamp giving an approximate simulation of an average noontide daylight (Fig. 8, p. 12).

In like concise, lucid and systematic manner the author treats of all the various aspects of his subject; we can, however, do no more than glance at a few of the more important features

A specially important chapter from the standpoint of recent progress is that on "Solvents and Plasticisers," pp. 231 to 266, and this chapter may be looked on as largely introductory to the immediately following chapter on "Resins, Gums, Waxes and Bitumens": these two chapters giving the leading new features in the chemistry of the subject. In the old aspects of oil painting we may almost say there was but one solvent, the distilled essential oil of turpentine, although chloroform, the head and type of the chlorinated solvents, was brought into use by artist-painters more than half a century ago for removing old paint from brushes. The author, on p. 255, mentions the use of chloroform for removing free sulphur from ultramarine or from cadmium sulphide.

Soon after acetylene became an industrial product (about 1895), its chlorinated derivatives were manufactured on a large scale, and these with ethers, ketones, hydrocarbons and alcohols, swell the long list of modern paint solvents.

Cellulose ester paints, p. 368, may be regarded as modern, full-bodied successors to the old attenuated collodions; a special nitro-cellulose giving low viscosity being used. In sequence to this class we have (p. 371) an interesting account of silica ester paints which contain an organic silicate, as, for example, ethyl silicate. This constituent gradually undergoes hydrolysis at the outer surface by the action of atmospheric moisture; a coating of silica comparable to agate or opal being the result.

We ought not to close our notice without brief mention of the notable and serviceable modernism of Mr. Heaton's work in the matter of mechanical appliances, as in Fig. 28, which occupies the whole of p. 47, and shows us the principle of the Raymond machine for simultaneous grinding and separation of the fine particles by air flotation; while the next page indicates all essential details. Present-day drying plant in its keenest aspects is illustrated and explained on pp. 58-61: the best physical conditions being that the damp substance shall be spread out or divided, kept in motion under controllable warmth, and all this *in vacuo*: conditions realised "when the vacuum chamber takes the form of a rotary drum." The white lead manufacture in its standard "Dutch method" of acetic corrosion, is illustrated and explained in its most recent features on pp. 64-80, and by Figs. 45 to 50. Perhaps the most notable feature is the last, a "carding machine" for lead, whereby the metallic lead is reduced to a condition comparable to carded wool, and so becomes eminently suited for uniform corrosion.

We are now less than half-way through the series of 109 illustrations, each one of which might be used as a text for comments: we however, turn once more to p. 368, where the two concluding illustrations are to be found, aluminium churns, for use in preparing cellulose ester paints. Here is a book to be valued by all interested in the manufacture of paint.

ELEMENTS OF BOTANY. By Richard M. Holman and Wilfred W. Robbins. New York: John Willy and Sons, Inc. London: Chapman and Hall, Limited. 17*s*. 6*d*. net.

The authors are known as efficient University teachers in the United States and as having written various essays and treatises on botanical subjects. Here we have a joint effort to produce what is termed in the preface a book for "one semster" work in the high school or university. On this side of the Atlantic a "second step" or "student's compendium" would be a good description.

There are, we estimate, between 700 and 1,000 clearly defined line illustrations of botanical fundamentals, and a useful feature of the full and helpful 20-page index is that when a subject is illustrated an asterisk is printed alongside its page number in the index.

As an example of the admirable way in which the authors combine illustration and text, we suppose the book to be open at pp. 212-213. On the left-hand page, Fig. 132 shows us four illustrations of stages in multiplication, by cross fission, of the common green alga, often called "*Protococcus*," while on our right the multiplication of the more complex filamentous alga "*Ulothrix zonata*" is shown by the nine illustrations embodied in Fig. 133. Here two sequently numbered figures embody thirteen illustrations, hence our uncertainty in estimating the total contained in the book.

From all standpoints the book is satisfactory, and it is a definitely valuable addition to the resources of the student.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock.

MARCH 20.—PROFESSOR A. E. RICHARDSON, F.R.I.B.A., Professor of Architecture, University of London, "Modern English Architecture" THE RIGHT HON. LORD STANMORE, C.V.O., will preside.

APRIL 10.—G. H. NASH, C.B.E., European Chief Engineer, International Standard Electric Corporation, "A Brief Review of Speech Communication by Electric Methods."

APRIL 17. F. E. LAMPLOUGH, M.A., "Vita Glass"

APRIL 24.—H. L. FLETCHER (of the British Broadcasting Corporation), "The Educational Value of Broadcasting."

MAY 1.—P. MORLEY HORDER, F.S.A., "Architectural Models."

MAY 8.—CHARLES J. FFOULKES, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts." PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, will preside.

MAY 15. ROBERT BURRELL, Barrister-at-Law, "The Reform of the British Patent System"

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

APRIL 12. A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India."

MAY 10. P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.)

DOMINIONS AND COLONIES SECTION.

Tuesday afternoons, at 4.30 o'clock.

MARCH 26. H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa" PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., Vice-President of the Institution of Mining and Metallurgy, will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

SIR E. DENISON ROSS, C.I.E., Ph.D., "Nomadic movements in Asia." Four Lectures: April 22, 29, and May 6, 13.

LECTURE I. The Exodus of the Arabs in the Seventh Century.

LECTURE II. The first westward movement of the Turks in the Eighth Century.

LECTURE III. The invasion of Middle Asia by the Seljuks in the Eleventh Century.

LECTURE IV. The Mongol invasion of the West in the Thirteenth Century.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 18..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. M. Isacco, "The Helicogyre"

Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Special and Business Meetings.

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Method in Invention," opened by Mr. C. Turnbull.

At the University, Liverpool. 7 p.m. Mr. E. Y. Robinson, "Radio Sets on the Mains"

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. O. G. S. Crawford, "Air Photographs of the Middle East."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Mr. Keith-Brinsmead, "Locomotive Lubrication"

At the Merchant Venturers' Technical College, Bristol. 7 p.m. Mr. H. L. Guy, "Modern Development in Steam-Turbine Practice."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. H. Wickham Steed, "The War and Democracy in Central Europe." (Lecture IV).

At University College, Gower Street, W.C. 5.15 p.m. Prof Hans Przibram, "Connecting Laws in Animal Morphology." (Lecture IV).

5.30 p.m. Dr. C. J. Sisson, "English Literature among Professors and Students."

5.30 p.m. Mr. James Bonar, "Demography in the 17th and 18th Centuries." (Lecture VI).

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. The Rev. A. H. Finn, "Conjectural Emendations in the Psalms."

TUESDAY, MARCH 19..Automobile Engineers, Institution of, at 83, Pall Mall, S.W. 7.45 p.m. Demonstration and Discussion of Inventions.

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. Conrad Gribble, "Impact in Railway-Bridges, with particular reference to the Report of the Bridge Stress Committee." (Further discussion).

Electrical Association for Women, at 15, Savoy Street, W.C. 7 p.m. Mr. H. Bourne, "Some Elementary Facts concerning Electric Motors."

Electrical Engineers, Institution of, at the Engineer's Club, Manchester. 7 p.m. Messrs. T. N. Riley and T. R. Scott, "Electrical Insulating Papers for the Manufacture of Power Cables." Mr. S. G. Brown and Mr. P. A. Sporing, "The Prevention of Ionisation in Impregnated Paper Dielectrics."

At the Town Hall, Loughborough. 6.45 p.m. Mr. Ll. B. Atkinson, "How Electricity does Things." (Faraday Lecture).

Empire Society, at the Cannon Street Hotel, E.C. 1 p.m. Mr. John Ryan, "The Cotton Industry."

Heating and Ventilating Engineers, at Milton Hall, Manchester. 7 p.m. Paper by Mr. A. E. Cubbage.

Illuminating Engineering Society, at 15, Savoy Street, W.C. 6.30 p.m. Mr. Walro Maitland, "Architectural Lighting."

Metals, Institute of, at the Engineers' Club, Birmingham. 7 p.m. Dr. N. F. Budgen, "Aluminium."

At Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Dr. Stanley W. Kemp, "Antarctic Whaling Expeditions."

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Dr. E. C. Snow, "The Limits of Industrial Employment."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. Philip Burtt, "What Education does a Transport Man Need?"

At the Queen's Hotel, Birmingham. 6 p.m. Mr. E. W. Bayliss, "Transport on Inland Navigations—its Advantages and Limitations."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. R. W. Seton-Watson, "The Eastern Question." (Lecture X).

Zoological Society, Regents' Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, MARCH 20..Chemical Engineers, Institution of, at Grosvenor House, Park Lane, W. 11.30 a.m. Sir Alexander Gibb, Presidential Address, "The Co-ordination of Engineering Institutions and Societies."

2.15 p.m. Prof. Dr. B. P. Haigh, "Chemical Action in Relation to Fatigue in Metals."

Egypt Exploration Society, at Burlington House, W. 8.30 p.m. Mr. H. A. R. Gibb, "Foreign Policy of Egypt in the Muslim Period."

Electrical Engineers, Institution of, at Mappin Hall, Sheffield. 7.30 p.m. Prof. Dr. W. Cramp, "The Cause and Effect of Oscillation in Electrical and Mechanical Apparatus."

At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Mr. R. W. Gregory, "Electric Supply to the Rural Districts of England."

Geological Society, Burlington House, W. 5.30 p.m.

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

Meteorological Society, 49, Cromwell Road, S.W. 7.30 p.m. Mr. R. A. Watson Watt, "Weather and Wireless." (G. J. Symons Memorial Lecture).

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. Dr. H. Moore, "The Mode of Formation of the Image in the Microscope."

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Admiral of the Fleet the Right Hon. Lord Wester Wemyss, Presidential Address. Sir William J. Berry, "H.M. Battleships 'Nelson' and 'Rodney'." Lt.-Col. F. Dondona, "Sea Trials of Italian Destroyers."

University of London, at the London School of Economics, Houghton Street, W.C. 6 p.m. Mr. J. R. Bentley, "'Hollerith,' To-day and To-morrow."

THURSDAY, MARCH 21. Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Automobile Engineers, Institution of, at the Technical School, Gloucester. 7.30 p.m. Mr. L. W. Johnson, "The Inspection of Metals and their Alloys."

Electrical Engineers, Institution of, Savoy Place, W.C. 5.30 p.m. Demonstration by Mr. R. T. Coe of a Portable Electric Harmonic Analyser. 6 p.m. The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages." Mr. J. A. Kuyser, "Recent Developments in Turbo-Generators."

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. John Hooper, "The Furnishing of Official and Diplomatic Residences."

Mechanical Engineers, Institution of, at Queen's Hotel, Birmingham. 6.30 p.m. Messrs. A. J. Assheton and A. G. Engholm, "Sub-Atmospheric Heating."

At the Engineers' Club, Manchester. 6.30 p.m. Mr F. C. Johansen, "Research in Mechanical Engineering by Small-Scale Apparatus."

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Mr. John Johnson, "The Propulsion of Ships by Modern Steam Machinery." Dr J. Bruhn, "Some Considerations Regarding International Loadline Regulations."

3 p.m. Dr. G. Kempf, "New Results Obtained in Measuring Frictional Resistance." Mr. C. F. A. Fyfe, "The Practical Use of the First British-Built Bauer-Wach Exhaust Steam Turbine Installation in the Booth Liner 'Boniface'."

8 p.m. Professor C. E. Inglis, "Natural Frequencies and Modes of Vibration in Beams of Non-Uniform Mass and Section." Mr. S. A. Hodges, "The Behaviour of Stiffened Thin Plating under Water Pressure."

Royal Institution, 21, Albemarle Street, W. 5.15 p.m. Rev. W. H. Draper, "The Change in Meaning from one Period to Another."

Sanitary Institute, 90 Buckingham Palace Road, S.W. 3 p.m. Sir Humphry Rolleston, "Industrial Disease and its Prevention."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Twentyman, "German Education since the War." (Lecture VI).

FRIDAY, MARCH 22. Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Mr. D. A. Collin, "Ventilation."

Medical Research International Association for, at the Royal Society of Arts, Adelphi, W.C. 7 p.m. Lecture by Dr F. W. Zeylmans van Emmichoven.

Naval Architects, Institution of, at the Royal Society of Arts, Adelphi, W.C. 11 a.m. Eng. Rear-Admiral W. Scott-Hill, "Powdered Coal for Ships." Mr. A. Spyer, "Modern Developments of the Water Tube Boiler for Marine Purposes." Eng. Rear-Admiral A. E. Hyne, "Suggested Modifications to Marine Water Tube Boilers."

3 p.m. Mr. J. Rennie Barnett, "Motor Life-Boats of the Royal National Life-Boat Institution."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Annual General Meeting. Dr. W. H. Eccles, F.R.S., Presidential Address.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Ernest Rutherford, "Penetrating Radiations."

University of London, at University College, Gower Street, W.C. 5 p.m. Mr. C. F. A. Pantin, "Comparative Physiology." (Lecture X).

SATURDAY, MARCH 23..L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. M. A. Phillips, "Mammals of Britain."

Royal Institution, 21, Albemarle Street, W. 3 p.m. Sir Ernest Rutherford, "Molecular Motions in Rarefied Gases."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3983. VOL. LXXVII.

FRIDAY, MARCH 22nd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

TUESDAY, MARCH 26th, at 4.30 p.m. (Dominions and Colonies Section). H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa, "The Base Metal and Mineral Resources of South Africa." PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., will preside.

Tea will be served in the Library from 4 o'clock.

PURCHASE OF WEST WYCOMBE.

It has been felt for some time that the Royal Society of Arts should extend its work for the Preservation of Ancient Cottages by acquiring complete villages in order to show the public what can be done by intelligent control of its traditional values. The idea originated during the chairmanship of Sir Frank Baines, and was encouraged by Sir Lawrence Weaver, who, after a visit to America, reported that he could find very little support for a general and vague scheme for saving scattered cottages, but that he hoped help would be forthcoming if certain definite villages could be taken in hand. Sir Howard Frank was then asked to report on any suitable villages that might come into the market. He suggested one or two in Wiltshire, and also West Wycombe in Buckinghamshire, which was to be put up for auction in a very few weeks. A lady in the district at once offered to contribute £500, and assured the Committee that others in the neighbourhood would be glad to assist, in order to prevent the village being handed over to a number of irresponsible owners, who would quickly change the whole character of the place.

Sir John Dashwood, of West Wycombe Park, owner of the village, was approached. Appreciating the advantages of selling to a responsible society

who would have complete control of the buildings and whose object would be solely to restore and retain their true character, he did everything in his power to further the scheme both in settling the price and promising a subscription of £500 to the repair fund. Various members of the Executive Committee visited West Wycombe; an emergency meeting was called to consider Sir John Dashwood's offer, and they unanimously recommended the Council to accept it. The Council at their meeting on March 11th agreed to make the purchase and authorised the payment of the deposit.

The village of West Wycombe is particularly interesting by reason of its close proximity to the unpleasing suburban outcrop of High Wycombe on the one side and the fine open country on the other. It is bounded on one side by West Wycombe Park and on the other by common land, so that if the village is once placed in good order there is little danger that it will ever be spoiled. Lying on the high road between Oxford and London, it will be seen by large numbers of people, and it is hoped that the work of preservation begun here may lead to similar developments in other counties.

A strong local committee is being formed in Buckinghamshire with a view to raising the money necessary to pay for the purchase of the village and to carry out the necessary repairs. An appeal has been issued and already a substantial sum has been received or promised. The Society is most anxious not to deplete its resources for dealing with other pressing problems and therefore hopes to get a sum of at least £20,000 for this particular purpose. All those who are interested in saving this very picturesque village are requested to send their subscriptions to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2, by whom they will be gratefully acknowledged.

HISTORY OF THE ROYAL SOCIETY OF ARTS.

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15s. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

COUNCIL.

A meeting of the Council was held on Monday, March 11th. Present:— Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Lord Bledisloe, P.C., K.B.E.; Captain Sir Arthur Clarke, K.B.E.; Sir William Henry Davison, K.B.E., D.L., M.P.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Mr. P. Morley Horder, F.S.A.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E.,

D.S.O.; Sir Philip Magnus, Bt.; Sir Richard Redmayne, K.C.B.; Col. The Master of Sempill; Mr. James Swinburne, F.R.S.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas; Sir Frank Warner, K.B.E., and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary)

The following candidates were duly elected Fellows of the Society:—

Adams, Alfred Courthope, London.
Baird, John Logie, London.
Barnes, James Haydn, M.A., Bath.
Candish, Herbert Douglas, Edgware.
Davidson, Thomas William, Totteridge, Herts.
Edwards, James Herbert, M.I.E.E., Cranham, Glos.
Hall, Captain Joseph Lockwood, F.R.I.B.A., Pretoria.
Howells, Frederick Walter, Bristol.
Hubbard, E. Hesketh, R.O.I., A.R.W.A., R.B.A., Salisbury.
Impey, Frederic Paul, London.
Lofts, Harold George, West Harrow.
Singh, Dr. Jaswant, L.M.P., Kashmir.
Taylor, Gilbert, London.
Turner, Captain J. Dare Knobbs, A.M.I.Mech.E., London.

A statement by Mr. P. Morley Horder, Chairman of the Committee of the Fund for the Preservation of Ancient Cottages, recommending the purchase of the village of West Wycombe, was considered, and the recommendation of the Committee was approved. [See page 475.]

A report from the Thomas Gray Memorial Trust Committee was approved, and prizes to the value of £100 were awarded. [See below].

The number of entries for the March Examinations was reported—26,882.

A quantity of financial and formal business was transacted.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1929 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 30th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce."

A list of those who have received the medal since its institution in 1864 was printed in the last number of the *Journal*.

THOMAS GRAY MEMORIAL TRUST.

Award of Prizes.

Prize for an Invention for the Improvement of Navigation.—Under the Thomas Gray Memorial Trust the Council offered a Prize of £100

for a valuable improvement in the Science or Practice of Navigation. The last date for receiving entries for this Prize was December 31st, 1928. Ten entries were received. These were carefully considered by the judges appointed by the Council, who report that in their opinion none of the inventions submitted was of sufficient value to justify the full award of the Prize. There was certain merit or interest, however, in two of them, and in accordance with the judges' recommendation the Council has awarded prizes as follows:—

A Prize of £30 to Lieut. Donald MacMillan, R.N.R., for his "Navigators' Ex-Meridian Diagram," and

A Prize of £20 to Captain John Barrance Browning for his "Browning Star Plotter."

PRIZE FOR AN ESSAY. The Council also offered a Prize of £50 for an essay on "The Practice of Navigation in the Mercantile Marine." Eighteen essays were submitted and in accordance with the unanimous recommendation of the judges, the Council has awarded the Prize to Mr. P. S. Atkins, Second Officer, T.S.S. "Sarpedon," Blue Funnel Line.

FIFTEENTH ORDINARY MEETING

WEDNESDAY, MARCH 13th, 1929. DR. WILLIAM HENRY ECCLES, D.Sc., F.R.S., in the Chair.

A Paper on "Loud Speakers," was read by MR. R. P. G. DENMAN, A.M.I.E.E., of the Science Museum, South Kensington. The Paper and discussion will be published in the *Journal* dated May 17th.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

WEDNESDAY, JANUARY 30TH, 1929.

JAMES SWINBURNE, ESQ., F.R.S., in the Chair.

The following paper was read:—

THE SHANNON SCHEME AND ITS ECONOMIC CONSEQUENCES.

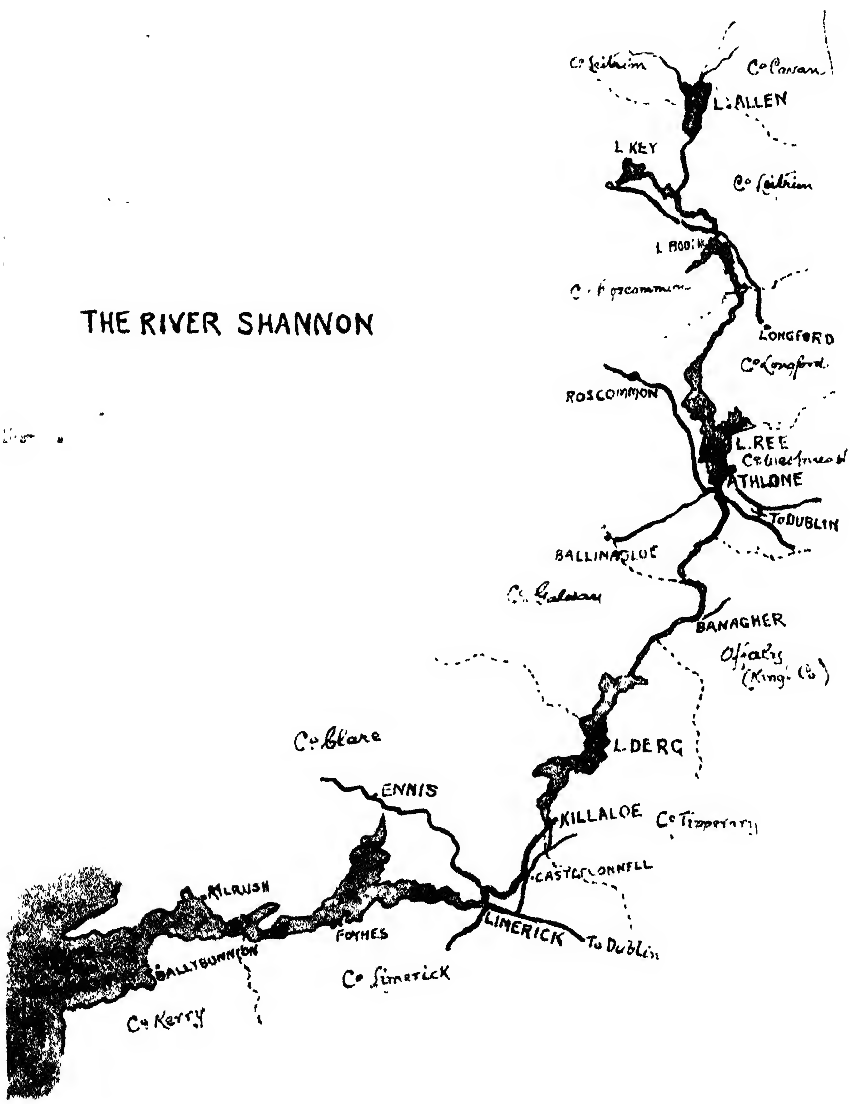
By GEORGE FLETCHER, M.A., F.G.S., M.R.I.A.

In a paper on "The Power Resources of Ireland," which I had the honour to read before this Society in 1922, under the Chairmanship of the late Sir George Beilby, I gave some particulars of the water power resources of Ireland

and of the findings of the Water Power Resources of Ireland Sub-Committee of the Board of Trade. This Committee, of which I was a member, had as its Chairman a very distinguished Engineer—Sir John Griffith. It recommended, *inter alia,* a development of the water power of the Shannon. The Scheme suggested was different in character and on a much smaller scale than that which was untimately adopted by the Free State Government, and which I am about to describe. The Committee, which reported on December 6th, 1920, submitted detailed schemes for the development of the Lower Bann, the Lower Shannon, the Lower Erne and the Liffey, and expressed the opinion "that in most cases the most effective and economical method of dealing with our rivers for power purposes is to construct the necessary works in the channel of the river, and not to attempt to seek high falls by the construction of costly head-race channels, into which a portion of the river flow would be diverted from the channel proper." The Report set out the advantages of adopting such a course, and the scheme submitted by Mr Stephens proposed to erect four hydro-electric power stations on the Shannon between Killaloe and Limerick, with an installed electrical horse-power of 65,900, at a total cost (under the then current prices) of £2 834,000, or at the rate of £43 per installed E H P. The average annual output obtainable would be 52,000 E.H.P., at a capital cost of £54 per average E.H.P. It is unnecessary at this time to explain fully the reasons which induced the Committee to recommend this scheme of progressive development, but chief among them was that of dispensing with a costly head-race, the conservation of fishery interests, the improved navigation facilities and the progressive development in relation to demand for current.

This is neither the time nor the place to discuss the reasons for the promulgation of a scheme which differed so widely from that recommended by the Committee. The question is discussed at some length in the Report of the Experts, to which reference is made later. The Committee were agreed that such large rivers as the Shannon should be in the control of a Department of State. Previous attempts to develop the river had been baulked by rival, though subsidiary, interests, and it became clear that these needed the authority of the State to bring about such reconcilement as was possible under any large scheme for the production of power from the river. An instance of this conflict of rival interests is that afforded by the earlier proposal of Mr. Frazer. An Act of Parliament was passed in 1901 (1, Ed. VII, c. 136), under which it was proposed to divert a portion of the river water below Killaloe to a power station, but the restrictions inserted in the Act, at the instance of the Board of Public Works and the Department of Agriculture and Technical Instruction in the interests of navigation and fisheries, proved fatal to the proposal, which was not proceeded with. Further proposals were made by Mr. Stephens, who, after extensive surveys in 1915, on behalf of the Irish Hydro-Electric Syndicate, proposed to follow the lines of the Act of 1901, adopting its restrictions, and

obtain 40,000 h.p. for from 17 to 20 weeks in the year and 17,000 h.p. throughout the year. The intention was to obtain power for the manufacture of ferro-chrome. The Water Power Resources of Ireland Sub-Committee was appointed on November 29th, 1918, and reported on December 6th, 1920. The problem was further considered by a Commission of Inquiry into the Resources and Industries of Ireland, which reported in 1922. An agreement, published as a White Paper, was made between Messrs. Siemens-Schuckertwerke and the



Irish Free State Government in February, 1924. Their proposals were submitted to the experts appointed by the Government, and these, in the early part of 1925, recommended, with some modifications, the adoption of the scheme. The scheme now in progress was passed by Dail Eireann on April 3rd, 1925, and the Shannon Electricity Act passed the Oireachtas in June of the same year.

Before describing the scheme it will be useful to give some particulars about the river. The Shannon is the longest of our Irish rivers. The total length of its main stream, exclusive of the tidal estuary below Limerick, is about 160 miles, and its catchment basin, above Killaloe, has an area about one-eighth of the total area of Ireland -over 4,000 square miles. Above Killaloe, the river, meandering over the central plain and passing through its three large lakes, Lough Allen, Lough Ree and Lough Derg, has, in 125 miles of its length, a fall of only 55 feet less than 6 inches per mile. Flooding of the areas adjacent to the river has been a constant source of trouble, and has been considered by a number of important Commissions. The question still offers a problem of pressing importance. In September, 1924, the Free State Government submitted the scheme offered by the Siemens-Schuckert Company to four experts for examination and report. These were Messrs. Waldemar Borgquist of Stockholm, Eugen Meyer-Peter of Zurich, Thomas Norberg Schulz of Christiania and Arthur E. Rohn of Zurich. These gentlemen, in their Report, drew attention to the importance of the drainage problem, and recommended the Government to have a drainage scheme prepared for Shannon areas subject to flooding, in connection with the lake and river regulation necessary under the Power Scheme. They, at the same time, expressed the opinion that, in spite of the often-expressed fears to the contrary, the hydro-electric exploitation of the Shannon, especially in the full development, will regulate conditions as regards maximum height of water and flood prevention, providing in addition the protective constructions which at present are lacking, and also that the developed electrical energy may be used to a far-reaching extent to drain areas in the country subject to flooding.

Below Killaloe, and from there to Limerick, a distance of 15 miles, the fall over the river is over 90 feet, or 6 feet per mile, and this fall is being utilised for the production of power. It is obvious that the first point of importance in such a matter is the flow-off conditions involving both quantity and time. In this matter the conditions in Ireland are very favourable as compared with most Continental countries, for the greatest flow occurs in winter, when the demand for energy is greatest.

It was of great advantage that there was in existence an extensive record of observations (made by the Board of Works), both as regards rainfall in the area and of Water level at various points. These have been discussed in the Report of the Experts appointed by the Government: "The Electrification of the Irish Free State" (Dublin, The Stationery Office). I do not propose to

Shannon Power Scheme.—Sketch diagram.

enter into the difficult and complicated question of flow-off, but with a rainfall of 946 m.m., the average discharge of water in the lower part of the river is 240 c.b.m. per second. The maximum discharge in flood is 918 c.b.m. per second and the minimum dry-weather flow is 25.4 c.b.m. per second—thus the ratio of the largest quantity of water in flood to the lowest quantity in dry weather is 36.1. It will be clear that to utilise the energy to the full it will become necessary to impound the water during the period of heavy flow in order to supplement the flow in the dry weather period, and it is this which renders the question of storage in the lakes one of great importance. By raising the level of the lake reservoirs the amount of water stored may be increased at a cost of flooding the neighbouring lowlands. By lowering the level of the lakes a large amount of the stored water may be used when needed, but this course is attended by difficulties which arise from altering the navigation level and the like. In the present case the "partial development" of the Shannon—the existing maximum and minimum levels of the three lakes will not be interfered with, except in the case of Lough Derg, the level of which, while it will be maintained at its present winter level as far as may be, may be lowered two feet in a dry year, by which a storage of 186 million c.b.m. will be secured.

The Scheme contemplates development in three stages: (1) the Partial Development, involving the lowering of Lough Derg by two feet, the protection of the land on its shores, where necessary, by embankments, the land behind which will be drained by pumps, bringing the water back into the lake; (2) the Further Development, involving a new weir at Lough Ree and the rebuilding of the Lough Allen Weir; (3) the Final Development, in which the storage of the three lakes will be increased by a further raising of the maximum water level of Lough Derg by nearly 7 ft. (2.10 m.).

The Partial Development (which necessarily includes certain provision for subsequent developments) consists of a diversion of a part of the Shannon river along a head-race, which conveys the water at a constant level until it reaches the Power Station weir, where it is carried through steel penstocks to the water turbines, which are connected by vertical shafts to electric generators placed above them, and is then discharged into the tail-race, which joins the river nearly $1\frac{1}{2}$ miles below. Thus a fall of some one hundred feet is utilised. The water level in the tail-race is influenced by the tide, but the net fall varies from 86 feet to 115 feet. At normal water level and average tide it is 94 feet.

The important structural elements of the Scheme are then seen to be: (*a*) the intake works and embankment and control works up stream; (*b*) the head-race with the bridges over it and the siphons under it; (*c*) the penstocks and power house, with its turbines and electric generators; and (*d*) the tail-race.

THE INTAKE WORKS.

It will be seen from the plan that these provide for a weir controlling the amount of water admitted to the river, which is regulated by the sluices, so as to provide the quantity required in the head-race, while the admission of water to the latter is controlled by sluice gates in the three openings of the intake building, each 25 m. wide and 5.7 m. deep and worked -- either electrically or mechanically - from the roofed gangway above This also provides a ships' pass 10 m. wide and 5.9 m. deep. Underneath this building is a reinforced concrete siphon to take the water of the Black river, etc , into the Shannon below the weir. This siphon is nearly 400 feet in length The weir will raise the river level about $23\frac{1}{2}$ feet above the present average level involving embankments between the weir and Lough Derg The intake works and

Weir Intake Works looking upstream. Steel Gates under erection.

weir are near Parteen Villa and are built on an old red sandstone foundation.

The very important question of the erosive effect below the weir was made the subject of experimental investigation, and for an account of the model experiments carried out at the Technical High School, Berlin, I am indebted to a paper recently read by Professor Rishworth, Government Engineer for the Scheme, before the Institution of Civil Engineers of Ireland. The weir design provided for four openings, each 18 m. wide, with weir crests at a level of 33.00 m. (full development), and two deep sluices, 10 m. wide, with weir crests at a level of 24.80 m. (partial and full development). The river bed downstream was taken at an average level of 24.50 m., and the upper surface

of the rock at 22.00 m. The river bed at the weir consists of old red sandstone covered with shingle and silt. The river, however, is too near Lough Derg for there to be any silting up of the river bed above the weir. The maximum flood was taken as 920 cb m. per second, and it was assumed that it may all have to be discharged through the weir in case the Power Station is closed down altogether and no water is flowing through the head-race.

The preliminary experiments clearly indicated that considerable erosion downstream might be expected from the deep sluices, and it was decided to keep them in the centre of the river so as to minimise the erosion of the banks.

The model was made to a scale of 1 to 50 Doctor Ing Ludin, under whose supervision the experiments were carried out, made numerous experiments to determine the nature of the sand most suitable to be used to represent the existing hydraulic phenomena.

An exhaustive series of experiments were carried out, for an account of which I must refer you to the paper quoted They led to a modification in the design of the weir. The question arose as to whether a stop wall was necessary at the end of the extended spill basin, and if so, of what section Experiment showed that the most suitable form was Professor Rehbock's toothed or dentated stop wall, but an almost equally satisfactory result was found with a wall of almost rectangular section with a uniform sill slightly sloping downstream with a height of 1 m. above the floor of the spill basin. The latter was adopted owing to its constructional advantage.

It was decided to adopt Model C as the basis of the weir design with certain modifications indicated by further experiments - thus the most suitable height for the stop wall was found to be 2 m. above the floor of the spill basin and maintained throughout the whole width of the weir.

Head Canal.

The construction of the head-race or inlet canal, by which the water is diverted from the existing river course and conveyed at a constant level a distance of over 7½ miles to the Power House, presents a series of difficult and interesting problems The question of speed of flow with partial and full development in relation to navigation, which will be through the head canal, the problem of preventing leakage and of possible injury which might result to the slopes of the canal by the waves set up by barges or of the swell resulting from a sudden shutting down of the turbines, the interference with the existing land drainage, are all problems which had to be met and overcome.

The experts were of opinion that a maximum speed of 1.5 metres per second might certainly be permitted. The greatest depth of water in the canal is 37 feet with a maximum width of 297 feet at the water surface. The bed is 104 feet wide and the side slopes are 1:3.

The canal passes through a rock cutting in two places - one of old red sandstone (between the intake and O'Brien's Bridge, and one of silicious

limestone at Clonlara. Provision is made for protection of the deep lying slopes and bed of the canal where these do not lie in rock by a layer of broken stones, and the upper part of the slopes subject to wave action are protected with concrete slabs.

The drainage of the area lying above the head canal is dealt with by culverts passing under it, the largest of these being the siphon under the weir which carries the Blackwater. There are also three bridges over the head canal.

PENSTOCKS AND POWER HOUSE.

The Power House is situated at Ardnacrusha, a few miles above Limerick. The building here, as elsewhere, is of reinforced concrete. The illustrations indicate the progress of the work and show the six openings to carry the

Shannon Power Station under construction as seen from Navigation Canal. (Photo by courtesy of Messrs. Siemens' Bau Union).

intake pipes and the navigation lock. Three of these only will be utilised for the Partial Development. They carry three steel pipe lines. These are 20 ft. in diameter and 145 feet in length and carry the water from the head canal (after passing through a screen, or "trash rack," to remove any stones or branches) to the turbines. The water then passes through a conical inlet pipe (tapering from 20 ft. to $15\frac{1}{2}$ feet in diameter) to the spiral housing (embedded in concrete), and thence through the guide-vanes to the turbine runner. It is then discharged through the draft tube to the tail-race.

The three turbines to be installed will each have an output of 38,600 h.p. These Francis turbines have vertical shafts connected directly to 30,000 k.w. 10,500 volt 50-cycle generators. The turbine speed will be 150 revolutions

per minute. The building of the generating station will provide for the installation of three further units of the same size in the future.

A thrust-bearing, mounted above the generator, will take the downward thrust caused by the weight of the revolving parts. These weigh about 20 tons and are designed to withstand a downward pressure of 480 tons. There are many interesting and important points connected with the speed control of the turbines and with lubrication, which is effected by means of a motor driven pump that of the thrust-bearing by a pump mechanically driven off the turbine shaft.

THE TAIL-RACE.

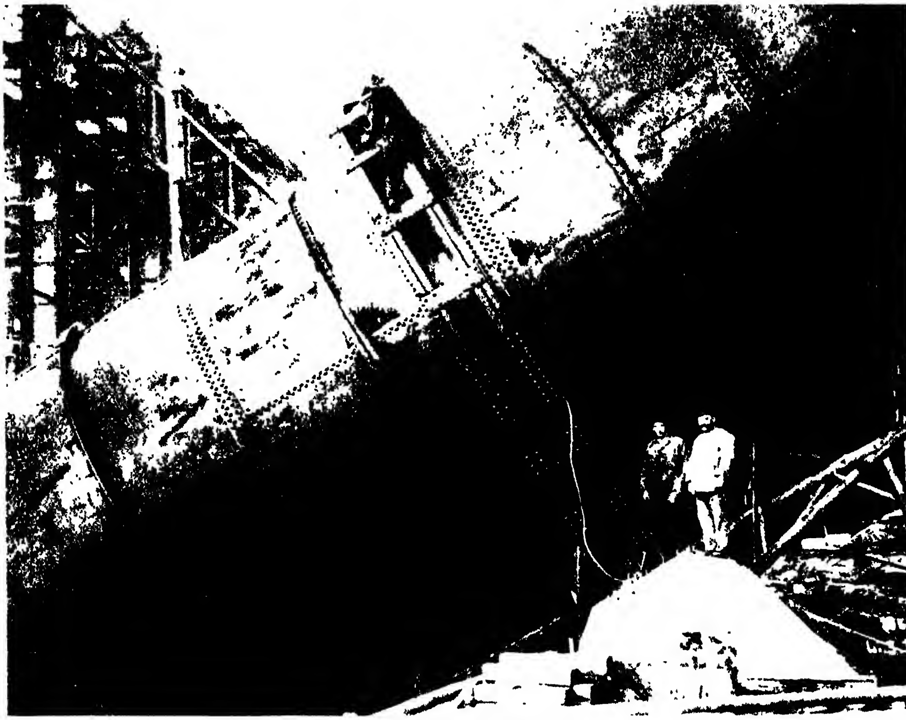
This is over 2,000 yards long and runs through rock. For the Partial Development it will have a width of 70 feet, but this width will be doubled for the Full Development. The current in this will not exceed 1.5 metres per second.

DISTRIBUTION.

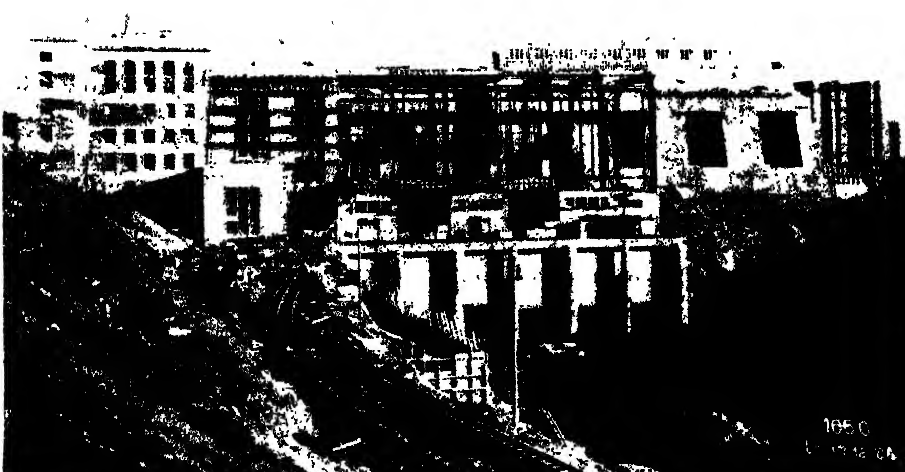
I have already stated that current will be generated at 10,500 volts. It will be stepped-up to voltages of 110,000 volts and 38,000 volts and distributed over nearly the whole of the Irish Free State by overhead high-tension transmission lines, as shown in the diagram, which shows the lay-out for the First or Partial Development. The 110 k.v. lines, which form the primary distribution system, will run from Ardnacrusha to Dublin (6 conductor) and from Ardnacrusha to Cork (3 conductor). These distances are 116 miles and 59 miles respectively. At each of these points are 110/38 k.v. transformers. The 38 k.v. transmission system is designed for the loop distribution, which, when completed, will extend about 1,040 miles At the points shown in the map are transformers for converting the current from 38,000 volts to 10,000 volts, and these stations supply a further distribution system. This system is for local distribution and will supply numerous transformer stations in cities, towns and villages, where the current will be transformed to voltages of 380 and 220 volts, which are the low tension voltages adopted for industrial and domestic consumers. The 110 k.v. lines are supported on lattice steel masts. The 38 k.v. lines are supported on lattice steel masts in the southern area and on wooden poles in the northern area, while wooden poles are used exclusively for the 10 k.v. lines.

The erection of the high transmission lines was the first work undertaken and is now in a very advanced stage. Rapid progress has been made with the Central Station work and it appears very probable that the supply will be available by October of this year.

It is only possible in the time at my disposal to give this general sketch of this great engineering undertaking—a work in which over 5,000 men have been employed and an elaborate equipment of modern engineering plant. It is



Penstocks under erection.



Elevation of Power House and Power Intake Works under Construction.
(Navigation Lock on Extreme Right).

hoped that advantage may be taken of the present stage of the work to visit and inspect this interesting project.

ECONOMIC CONSIDERATIONS.

I must, however, turn to a wider question, that of the economic developments which may be expected when electric power is available throughout the Free State. One is frequently met by the question uttered in a tone of obvious misgiving—whether this great Scheme will "pay"; and this is not uncommonly accompanied by an expression of doubt in the matter, because Ireland is "not an industrial country." The question is characteristic of our national attitude to such matters. The question is reasonable enough, but our national caution often leads us to defer action until a mathematic demonstration can be given, and this comes too late—the opportunity has passed. The exploitation of our water-power resources has been too long delayed, especially in Ireland, which has suffered from its lack of fuel. Yet even now he would be a bold man who should essay a mathematical demonstration of the economic success of the Shannon Scheme, though, in my own view, this success is assured. Permit me briefly to sketch the position as it is to-day. The chart on the screen shows the population of Ireland, the area of land under tillage and the number of cattle in Ireland in successive decennial periods since 1841. It will be seen that the population has rapidly declined and that in 50 years it fell almost by one-half from over 8 millions to slightly over 4 millions. It is still falling. It will be seen also that the area of land under corn crops decreased at about the same rate, and though there was a temporary recovery during the War the downward tendency continued. It appears that this causal relationship between decrease in tillage and population almost ceased to operate after 1881 (see Agricultural Statistics for Saorstat Eireann, 1847-1926). We need not consider too closely the causes of this. The supply of cheap corn from America and elsewhere affected farmers in Britain as well as in Ireland, where the cattle industry increased by leaps and bounds, but for the carrying on of which far less labour was required. Hence emigration took place at an alarming rate. But there was this difference in the effects produced in the two countries. In England the population migrated to the rapidly-growing industrial towns where power-factories near the coalfields absorbed the erstwhile agricultural labourer. In Ireland there were few industrial towns, there being very little coal, and so the population fell by emigration. In the last few years there has been great improvement in the organisation and marketing of products in the great dairy industry and other branches of agriculture in the Irish Free State, but it is becoming clear that a vigorous industrial revival is essential unless emigration is to continue. Efforts to promote industries other than agriculture in Southern Ireland during the last thirty years have been fitful and half-hearted. Official effort took the direction of encouraging home industries, and these achieved a large measure of success, were of considerable educational

value and proved a useful auxiliary to the earnings of the small farmer. This afforded no solution of the larger problem, however. The farming classes are not industrially-minded and the prospect of the mill chimney revolted them. The few industrial ventures which were attempted usually ended in failure. Concurrently a number of home industries followed the normal course of decay. The spinning wheel became a museum specimen or drawing-room ornament, thousands of hand-looms went on to the scrap-heap, the lace and crochet industries wilted before the vagaries of fashion, the once extensive "sprigging" industry of the north-west was largely lost to the machines of Switzerland and Germany, from which we sought with some degree of success to recover it. But it is a fact that machine industries have not come to take the place of the hand industries, although there are certain important industries in which the cost of power is a small, though not negligible, factor. Many once flourishing towns are falling into decay and have ceased to provide for the needs of the rural areas surrounding them, and articles which they once manufactured for themselves are now imported. This unhappy state of things is due largely, but not entirely, to the lack of fuel resources, and to-day industry calls for cheap power. The Free State has coal resources, but it does not compete with English coal and does not raise more than about one-fortieth of the quantity it imports. It has valuable peat resources - the salvation of the rural population, who use some six millions of tons every year for domestic purposes - and these reserves, which are abundant, will undoubtedly prove a great industrial asset in the future. Machine peat of good quality and having a heat value of about 7,200 B.T.U.'s per pound* (25 per cent moisture) can be won and stacked on the bog at Turraun for 10s. per ton. Certain problems of transport remain to be solved, but it seems likely that electric transmission may, in time, afford a revolution.

It will be seen from the foregoing that the primary economic need of the Irish Free State is cheap electric energy for lighting and power purposes, and this it will be the function of the Shannon Scheme to provide. The first effect will be to improve greatly the amenities of our country towns and to raise the standard of comfort of those living in them. There are approximately 130 towns and villages, with a minimum population of 500, in which no electric supply at present exists. As many of these as possible will be given the benefit of the current when it becomes available. Contracts have been given for the erection of distribution networks in more than thirty of them. Many of these towns are situated among beautiful natural surroundings, and the advantage of an electrical supply for street and house lighting will be of enormous value, social and economic, and will react on the growing tourist traffic, the importance of which has been recognised and has led to the formation of an Irish Tourist Association. A very important consideration also is that in such places the working day will be greatly lengthened.

*"Peat as a Domestic Fuel" by G Fletcher, Irish Trade Journal, April, 1927 (Vol. II., No 7.)

It is not possible at this stage to estimate to what extent the supply will be made use of by the agricultural industry, but with adequate propaganda it is certain to play a very important part in the staple national industry. Nor can one yet forecast the effect of the supply in attracting new industries, which require cheap power, but, arguing from analogy, the availability of cheap power, with other economic advantages, will almost certainly attract them. The surplus energy available in winter may also, in seasonal industries, afford winter employment to a certain number of otherwise idle workers, and we may hope that, as the experts expressed it, "the various proposals for the development of hydro-electric power at present put forward will in time come to be realised"

DISCUSSION.

THE CHAIRMAN said the audience had had a most excellent account of what was, he imagined, by far the greatest industrial undertaking ever ventured upon in Ireland. Everyone hoped it would be as successful as it looked likely to be.

PROFESSOR T WIBBERLEY said the Lecturer had given a most admirable paper, but had failed to deal with the application of electrical energy to what was, and what he (the speaker) always hoped would be, the greatest industry in Ireland, namely, agriculture A lot of trash had been talked about the application of electrical energy to agriculture. It had been stated that electrical energy was very good for pulping turnips The average farmer grew just about enough turnips to keep himself nicely warmed in the morning doing that by hand. Then it had been stated that electrical energy was a good thing for chaffing hay. Again, the average farmer only fed sufficient livestock to justify him occupying about one hour of his time cutting hay with which to feed his cattle in the winter-time If one was going to think on those small lines in connection with a big scheme like the Shannon Scheme one was not going to get very far. It was not only necessary to electrify the country , it was necessary to electrify the mentality of the Irish people--to give them a new outlook on life, to make them forget the past, and to live for a present and a future. He had only just returned from a fortnight's tramp through the peasant villages of Ireland, and he felt quite sure that the immediate development of the Shannon Scheme must be very closely linked with the country's agricultural development. Although we were living, both in this country and in Ireland, in a time of great agricultural depression, as a large farmer as well as a supposed scientist, he was convinced that the solution of the agricultural question in this country as well as in Ireland would be found in synthetic nitrogen—one of the greatest achievements of the present century. He would like to indicate how electrical energy could materially and directly benefit the farmers. It had been found, as the result of direct experiment, both in America and this country, that, by having an arrangement made whereby in the winter months a light was turned on in a fowls' house about one o'clock in the morning, the poor unfortunate hen was deluded into the belief that another day was dawning, the hens got down and had a feed and the result was that the output of eggs could be increased by no less than 25 per cent. People might not think much of that, but he remembered that at the time of the ill-fated Convention he had shocked a lot of people from Belfast, who had stressed a great deal the importance of the shipping and linen industries of Belfast, by pointing out that the net revenue of Ireland from the eggs and the feathers of fowls was

far greater than the net revenue from the shipping industry when it was in its heyday. Egg production was a very important industry in Ireland, and was likely to continue to be so. Synthetic nitrogen was about the one and only example there was of a modern scientific sword being turned into a ploughshare. The manufacture of synthetic nitrogen had occupied the minds of scientists for at least a hundred years, but not until nitrogen had been wanted for high explosives for destructive purposes had the necessary capital been forthcoming to help to make it. It had been made, however, and through the genius of Lord Melchett in this country at least, synthetic nitrogen had now been turned to agricultural uses. An organisation known as Nitram Ltd. had demonstrated one of the most important discoveries of the present century, namely, that by applying nitrogen heavily on pasture land not only could the period of grazing be increased by four weeks at either end of the ordinary grazing season, but the nature of the grass could be completely altered. In a country where 90 per cent. of the land was under grass, as in Ireland, that was bound to be of most outstanding benefit. The little work which he himself had done had been to try to start a system of arable stock farming with a view to providing cheap winter food, meat and milk; and the system of cropping to which he had referred was one which would do away with the importation of feeding stuffs for cattle and sheep through the winter. It had not been possible to apply it except on a small scale in the past, because one of the essential features in connection with that intensive system of arable stock farming was the supply of cheap nitrogen, and cheap efficient Farm Tractors; both were now obtainable. One of the big developments with regard to the Shannon Scheme was the conversion of the electrical power available for the manufacture of synthetic nitrogen.

There was another possible development. Despite what geologists said to the contrary, there had been discovered, and was now being worked, a huge deposit of rock phosphate in County Clare quite close to the Shannon Scheme, and a modern development with chemical manures was to make them contain not one but two elements of nutrition such as ammonium phosphate. With that huge deposit of rock phosphate so close, and the fact that it could be water-borne to any part of Ireland, and the existence of cheap electrical power such as was necessary for the manufacture of nitrate of lime and calcium cyanide, it seemed to him that the manufacture of synthetic nitrogen would mean the setting up of a very big industry, providing employment for a large number of industrial workers, and an immense benefit to the agriculture of the country. He was afraid the men who were going to carry out the necessary propaganda among the farmers of Ireland had a very difficult task before them. He was afraid they would never succeed with the older type of men, but there did exist the younger type of men. They were the hope of Ireland; they had taken up education, and it was those young men on which the future of the country must be built.

Mr. Llewellyn B. Atkinson (Past-President, Institution of Electrical Engineers) said the Society might congratulate itself on having this very important power scheme brought before it by one who was so competent to deal with it, and who was so conversant with its history. It had so happened that on Saturday he had had an opportunity of going all over the scheme when, through the kindness of the Chief of the Irish Electricity Board, every convenience had been placed at the disposal of himself and the President of the Institution of Electrical Engineers, who had accompanied him. While he felt that the audience had had a very admirable lecture, he was to a certain extent rather disappointed that they had not heard quite as much about the economics of the scheme as the title had led them to hope.

After he had been all over the scheme the question which had been left upon his mind, knowing something of the present possible consumption of Ireland, had been, " Is this all a dream ? " The whole thing was on so vast a scale. The slides shown that evening hardly conveyed the great size of the head race which was going to carry nearly the whole of the River Shannon along to the top of the turbines. The illustrations of the excavating machines did not give any idea of the immensity of those machines. He had never seen anywhere in Europe excavating being done on so wonderful a system. The question was, what was going to be done with all that enormous power because there would be 180,000 h p. eventually ? What was going to be done with it was the great question. Professor Wibberley had spoken of its part utilisation for the production of synthetic nitrogen although a good deal which had been said that night of the nitrogen processes had nothing whatever to do with water power, but were catalytic processes of uniting nitrogen with other materials Putting that on one side, however, he could not help having the sort of feeling that this great undertaking was a national gesture of a change which was going to come over Ireland The fact remained that to-day Irishmen were controlling their own destiny, and he believed that the Shannon Scheme was more than a mere engineering scheme It was an economic and psychological gesture that Ireland was going to change her methods and come into line with modern views of life and modern methods of life, both agricultural and industrial. If industry was to be attracted to Ireland it would only be so if industrialists found there an industrious and energetic population He agreed with Professor Wibberley in that connection with what he had said about the younger generation. He believed that the Shannon Scheme would reflect itself into the minds of that younger generation and would strengthen that will to work, which was the one thing which had been lacking for the last half century, in the southern part of Ireland at least. If that was the case, then he had no doubt, with this great source of cheap power at hand, that there would be no difficulty in industries going into Ireland. All kinds of industries which required great amounts of power could be planted there if the people there had the will to work at industry as well as farming. That was the view which during the last three days had been gradually percolating into his mind. The cost of the scheme was roughly £5,000,000 Of that sum, £2,500,000 was being put into the civil engineering works, of taking hold of the River Shannon, of carrying it along that seven miles of head race along the upper levels, and of putting it down again into the lower levels Another £2,000,000 would go into the overhead lines which were to take the power all over Ireland , and the actual machinery constructions, turbines and electrical equipment at the generating station and so on, and the transformers, would cost about £500,000. Therefore it was nearly all a matter of plant and of very little maintenance.

He strongly urged everyone who could to go over to Ireland and to inspect for themselves what was really a very wonderful work.

The Rt. Hon. Sir Thomas Molony, K.C , said he thought there was a great deal in what the previous speaker had said, namely, that this great Shannon Scheme could not be looked upon entirely as a mere work of engineering, but was to be regarded as having a deeper psychological basis as a new starting ground for the Irish people. Irishmen all looked forward to the fructification of this great industrial development in Ireland, which he hoped, as time went on, would bind England and Ireland together by still closer ties of friendship, whatever may have been the errors and misgivings of the past.

MR. R. BORLASE MATTHEWS, M.I.E.E., said it had been his privilege from time to time to see these wonderful works under development. One of the things which had struck him about the way in which the contract had been carried out was that one of the first things which the contractors had done had been to build an electric generating station to supply current for the operation of the works from their own plant. The locomotives, except in the regions where there were explosives in constant use, were electric, the digging machines were electrically operated, and, in fact, everything on the plant which could possibly be electrically operated was so operated. That was a wonderful example of what was going to be the use of the current after the work was carried out.

A number of very serious difficulties had had to be overcome, which had possibly delayed the completion of the work by some six months. First of all, there had been the human element. Then there had been a serious and unexpected pocket of earth just underneath the foundations of the turbines. In quite a number of places also, rock had been found where earth was expected, and earth had been found where rock was expected.

There was a very hackneyed saying that trade followed the Flag. He thought that could be paraphrased by saying that trade and industry also followed the supply of electricity. Agriculture was going to be one of the big users of electricity. He was satisfied that in most countries, including England, the agricultural load would eventually be bigger than the industrial load. People talked about the farmer being a small man, but quite forgot that in the aggregate he was the biggest worker on the face of the earth. Farmers had a strong business element; they did know what affected their pockets, but it was necessary for others to demonstrate to them the advantages of changes in their business. One of the biggest changes in farming in Ireland in the future would be electrical farming. The question was in how short a time that could be brought about. He had already heard rumours that model farms were going to be started, and he thought there could be no better propaganda than a series of model farms in different parts of the country where electricity was used in a reasonable and business-like way. Propaganda of that sort would help in showing how electricity could be used in agriculture, and would assist to bring back agriculture to its one-time prosperous condition.

MR. THEODORE STEVENS, M.I.E.E., said he would like to know if the figures which were not in the paper, but which had been in the experts' report, and in the Siemens-Schuckert scheme, were the ones which were to apply to the manufacture of nitrogen compounds. The Siemens-Schuckert scheme talked about .35d. per unit. The experts' report thought that was too high, and they talked about .15d. He happened to know that carbide, which had to be made first before cyanamide was produced, was produced by the Alby Carbide Company in Norway when their current had been costing them 25s. per horse-power-year (0.05d. per unit). Could the present plant supply the lighting load for Dublin, and still have available power for the manufacture of nitrogen compounds? He would like to know if 150,000,000 units was the contemplated output from the plant in a year (that was the figure in the experts' report, 48,000 kilowatts was given as the peak load), and if one divided 150,000,000 by the number of hours in a year an average load was obtained of 17,000 kilowatts. There was not a lot left to be given to nitrogen compounds.

CAPTAIN SIR ARTHUR CLARKE, K.B.E., said it was his pleasant duty to propose a vote of thanks to the lecturer for his most excellent and instructive address.

Personally he was not an electrician or a farmer; he was a seaman, and he would like to ask the lecturer whether the scheme was going to have any effect of any nature whatever on the lower reaches of the Shannon. He asked the question because some years ago there had been a great scheme to have a barrage at Gravesend, which he, as a seaman, had been against because he knew that if such a scheme were adopted the outer reaches of the Thames would be in a very short time like the outer reaches of the Dee all sand banks. Fortunately that scheme had fallen through.

The Lecturer said that the Shannon scheme would not have any effect whatever on the lower reaches of the Shannon the flow would of course be regulated.

Sir Arthur Clarke, continuing, said there had been a good deal said about Irishmen He himself was an Irishman and he had listened with some indignation and with some very great pleasure to what had been said about the Irish. The Irishman was conservative, but not a bit more so than the Englishman. The Shannon Scheme, brought about by the energy and the vision of Irishmen, helped by other nationalities, would, he hoped, achieve successful results. It was vision that was wanted In that connection he pointed to dock work. No dock in the world had ever been built big enough for the work which it had had to do a very few years after it had been constructed He congratulated his countrymen on this great scheme, and wished it God speed for the benefit of the dear old country.

Lieut.-Col. V. A. Haddick remarked that he lived at Limerick, and therefore was very interested in what was happening at Ardnacrusha The obvious thing to develop in Ireland was agriculture, because the wealth of Ireland lay in its agriculture. If electrical power could be used to develop agriculture, the day might come when exports from Ireland would go a very long way towards solving the food problem for the manufacturing millions of Great Britain. When the time came to form an Empire Ring of Dominion products and British manufactures, Ireland would not be found wanting.

The Chairman having seconded the vote of thanks, which was carried unanimously,

The Lecturer, in reply, thanked the members for the generous reception accorded to his paper and said he wished it were possible to deal with all the criticisms which had been made, but he feared that that was impossible, as these had been too numerous and had, indeed, sometimes wandered a little off the point. He agreed with Professor Wibberley that one of the effects of this great venture would be to electrify the minds of the people—although that would not be the only good thing it would do

If he had not dealt with synthetic nitrogen, the audience would understand after Mr. Stevens' remarks why he had not done so. He had dealt with that subject in his previous paper before the Society, about seven years ago, on "The Power Resources of Ireland," and also frequently in papers published in the Journal of the Department of Agriculture. He was a great believer in synthetic nitrogen, but he was not quite sure that it was going to be manufactured by means of electricity from the Shannon Scheme. The question involved was that of the cost of electric power, and he did not quite see how they were going to compete with Norway in the matter. Moreover, he had a pet view that in

Ireland they would be getting nitrogen from peat probably before they got it from water. There were conditions in Ireland which were very favourable to the manufacture of calcium carbide and calcium cyanamide. On the peat bogs there were the three things necessary for the work: there was an excellent peat charcoal; there was the underlying limestone, and there was the peat as a source of power on the spot. But he had been anxious not to go into hypothetical questions. He had been dealing with hard facts. He believed that the Shannon Scheme would have the effect of introducing new industries in Ireland, but he was not prepared to say exactly what those would be. He was not at all sure as to the synthetic nitrogen. He was sorry he had not been able to deal more fully with the economics of the question. He could have become very diffuse about that topic. Neither had he given any exaggerated idea of the greatness of the Shannon Scheme. He had failed to use superlatives. The scheme was a great gesture, as had been said. He could not allow the suggestion to pass that the Irishman was naturally idle. He was not idle at all—not nearly so idle as he himself would be under the same circumstances. The real truth was that he had lacked opportunity. He was glad that Mr. Matthews thought that electrical power would be brought into use on the farm as a labour-saving device, but he did not think that the agricultural load would ever become bigger than the industrial load, as Mr. Matthews had suggested. He did, however, think it would have a very great effect on the future of agriculture in Ireland.

The meeting then terminated.

"DAILY MAIL" IDEAL HOME EXHIBITION

For a brief period every year Olympia becomes the terrestrial paradise of our urban multitudes. Under its great roof, in an atmosphere which combines the ocular festiveness of a Christmas bazaar with the vocal delights of the cinema, are displayed all the elements, from the complete house down to the most insignificant gadget, which go to the making of the characteristic twentieth century home. An immense fountain of water, irradiated with light, plays in the centre of the hall, while a loud-speaker, claimed to be the biggest in the world, utters the tunes of unseen organs and orchestras for all to hear—even for those who are trying out pianola pianos. Obedient queues wait with decently concealed impatience outside the houses in the village of "Welcome In" till their turn comes. Wags go round to see what they can get for nothing in the way of samples. The penurious, controlling their wistfulness, invite obliging salesmen and saleswomen to put their ingenious wares through their paces.

In addition to the ruddy fruit and shining tins of preserved fish, etc., there is much food here for thought, for the reflective visitor. Does the press mould, or does it echo, public opinion? Is modern industrial design representative of those who demand or of those who supply? Did the first hen *lay* the first egg, or did it *come out* of the first egg?

I was struck by the good sense of the remarks made by various contributors to the guide-book to the exhibition. Their recommendations to the public are excellent. But the exhibition itself is no witness to the truths they set forth. The Enemy, disguised as half-timber—"this popular Tudor style"—and a high polish, lies everywhere in wait for the unsophisticated. Not that the village of "Welcome In" is all of this maudlin half-timber type. There is a cheap bungalow and there is a fairly expensive "Georgian" house, both of which are tolerable

outside and well-planned inside. It is a pity that in neither case should the interior decoration be unpretentious; on the other hand, the heating and washing arrangements are neat and good, and these are at the root of the house-keeping problem. Indeed, several firms display the most attractive bathroom sets, while others have different variations of the geyser which appear adequate.

Passing on to furniture, I noticed one sound modern room which seemed to be puzzling the imagination of a part of the crowd. It is shown by the Arundell Display Company, Ltd., 54, Davies Street, W., and is designed by A. D. Maclaren. Here is a real modern style: ingenuity is shown, but ingenuity carefully bound up with form. A lady was heard to ask: "Why is the bed so low?" One felt inclined to answer: "To save you looking underneath for burglars, Madam." A low bed, of course, saves space, and Mr. Maclaren, by a judicious use of glass, as for a very attractive table, effectively lightens and brightens his room. The gunmetal-coloured covering of the chesterfield is admirable; the peculiar dressing-table, the drawers of which swing out instead of pulling, appeared amusing and convenient. The metal doors of a cupboard let into the wall are absolutely simple and in harmony with the general design.

Among the most insidious pieces of bad taste at Olympia are the elaborate fretwork pictures shown by a firm which, as I happen to know from personal experience, can turn out very good work. The pitiless exploitation of the grain of certain woods is the *reductio ad absurdum* of the tendency, of which we hear so much at the present time, to believe that materials can dictate the technique in which they are to be worked. In bad taste, too, are the diminutive grandfather clocks of which just now there is a foison. What rhyme or reason can there be in such an evolution? Let us beware of the miniature; it is a sickly affectation.

The iron workers of Borough Green, Kent, show a small but interesting and encouraging selection of firescreens, hinges, gates and latches. The note in the catalogue suggests that work of this kind is particularly suitable for "Tudor style of buildings" (again!), but, of course, the Kentish smiths are perfectly able to carry out modern designs.

Generally speaking, Olympia gives the impression that neither skill nor money are lacking in the industries represented, but that these are, on the whole, badly laid out owing to the lack of good taste, or of freedom to express good taste, among designers. A slogan that might be more true than most suggests itself: "where there is not taste there is waste." At any rate, if worthless novelties were dispensed with, time and energy would be saved; for one has to go on thinking out novelties, while sound goods, once they begin selling, should continue to do so steadily or even with increasing momentum.

P. B.

NOTES ON BOOKS.

RATIONAL MECHANICS. By Lieut.-Col. Richard de Villamil, R.E. (ret.) London: E. and F. N. Spon, Ltd. 10s. 6*d* net.

By "Rational Mechanics," Lieut.-Col. de Villamil does not mean "mécanique rationelle"; he means mechanics consistent with reason. He considers that much of what is written by other authors is irrational and his object is to set them right. The book consists for the main part of quotations, some of which run to several pages, connected together with comments and statements of the author's own views; the last few chapters contain a development of the author's treatment of shapes of least resistance. The hero is Newton, the subject of the dedication, but even he is respectfully criticised (p. 151).

The purpose of the author is a good one; the basis of academic mechanics is not always as sound as it might be and there is much in current text-books that may be usefully criticised. What he does not appreciate is that before we may criticise, we must fully understand the subject of our criticism. This failure leads him to put forward views that are not merely unorthodox, but sometimes uninformed, and to attribute elementary errors to eminent writers, without seeing how unlikely it is that they should commit them. He divides mechanics (p. 110, etc.) into dynamics, a deductive science, which is purely vectorial, and energetics, an inductive science, which is purely scalar. In dynamics we are not allowed to refer to energy in any form, although we may to *vis viva*; indeed the "conservation of *vis viva*" is one of its fundamental principles. In energetics we may not mention velocity, momentum or force. Such views as these provide Col. de Villamil with ample occasions for dissenting from other writers.

Glazebrook is severely censured (p. 31) for saying that the work U done by a force F when its point of application is displaced a distance s in the direction of its action is given by U = Fs. This we learn is equating scalars and vectors; the equation is not "homogeneous" and is meaningless. The author does not appear to have met with vectorial multiplication and we are spared his comments upon this equation, when the force and the displacement have different directions. Glazebrook suffers in good company. Sir J. J. Thomson (p. 103), the late Lord Rayleigh (p. 134, etc.) and Einstein (Ch. V), among many others, receive severe handling.

One example of the author's constructive work must suffice. Maxwell is commended (p. 115) for saying: "According to Poisson's theory of internal friction of fluids, a viscous fluid behaves as an elastic solid would do, if it were periodically liquified for an instant and solidified again." This image, according to Col. de Villamil, is to be taken as a literal fact. "From this argument," he says, "a very curious fact, which Poisson and Maxwell appear to have overlooked, follows logically; viz., that the generation of heat takes place in quanta (I use the word "quanta" because it is the fashionable and learned expression which is generally employed). . . ." And the notion is developed at length.

Whatever may be said against the book, this may be said in its favour, that it contains an interesting collection of quotations, with ample references, and an index. Much care has been expended in its production; it is almost free from misprints and is excellently printed.

H.B.H.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MARCH 25..Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. The Hon. Sir Charles A. Parsons and J. Rosen, "Direct Generation of Alternating Current at High Voltages." At the University, Edmund Street, Birmingham. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the Grid Transmission System in Great Britain."

Imperial Cash-on-Delivery Association, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Wing-Commndr. T. R. Cave-Browne-Cave, "Aircraft Engineering in its relation to Mechanical Engineering."

TUESDAY, MARCH 26..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. C. Lucas, "The Nature of the Colour of Pottery with special reference to that of Ancient Egypt."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

London Vegetarian Society, at the Royal Society of Arts, Adelphi, W.C. 6.45 p.m. and 8.15 p.m.

WEDNESDAY, MARCH 27..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. D. H. Little, "Roads."

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5 p.m. Mr. A. M. Hallawell, "Acoustics in relation to the Gramophone and Radio Loud-Speaker."

THURSDAY, MARCH 28..Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Dr. D. S. Anderson, "The Future Development of the Locomotive." (Joint Meeting with Institution of Locomotive Engineers).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

HISTORY OF THE ROYAL SOCIETY OF ARTS.

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15s. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

SIXTEENTH ORDINARY MEETING

WEDNESDAY, MARCH 20th, 1929. LIEUT.-COL. SIR ARNOLD T. WILSON K.C.I.E., C.S.I., C.M.G., D.S.O., in the Chair.

A paper on "Modern English Architecture," was read by PROFESSOR A. E. RICHARDSON, F.S.A., F.R.I.B.A., Professor of Architecture, University of London. The paper and discussion will be published in the *Journal* on May 24th.

DOMINIONS AND COLONIES SECTION.

TUESDAY, MARCH 26th, 1929. PROFESSOR J. G. LAWN, C.B.E., A.R.S.M., Vice-President of the Institution of Mining and Metallurgy, in the Chair.

A paper on "The Base Metal and Mineral Resources of South Africa," was read by MR. H. WARINGTON SMYTH, C.M.G., M.A., F.G.S., M.I.M.M., late Secretary for Mines and Industries, Union of South Africa The paper and discussion will be published in the *Journal* on May 31st.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, FEBRUARY 26TH, 1929.

SIR WILLIAM J. LARKE, K.B.E. (Director, National Federation of Iron and Steel Manufacturers) in the Chair.

The following paper was read :—

THE SOUTH AFRICAN IRON AND STEEL INDUSTRY: ITS DEVELOPMENT AND POSSIBILITIES.

By H. J. VAN DER BYL, Ph.D., M.Am.I.E.E., F.I.R.E., F.R.S.(S.A.),
Chairman of the Electricity Supply Commission and the South African Iron and Steel Industrial Corporation, Ltd.

When the invitation was extended to me to read a paper before this Society on the Iron and Steel Industry of South Africa, it was considered, I understood, that a paper on this subject would be appropriate at this time, in view of the forthcoming meeting of the British Association for the Advancement of Science which is to be held in South Africa this year.

In accepting this invitation, which it gives me great pleasure to do, I must be modest enough to say that when I talk of the Iron and Steel Industry in South Africa, I am really talking of something that we hope is going to be, and therefore I may be excused if I dwell perhaps at greater length than would otherwise be justified on the more general economic conditions that must come into consideration in our efforts to establish the Iron and Steel Industry on a satisfactory footing.

On account of the pressure of my other work I am unfortunately not in a position to give accurate statistical details and supply the data that would make this lecture of more scientific interest, but I understand that a general survey of the position would serve the purpose.

Before discussing the possibilities of the Iron and Steel Industry in South Africa, it may be well to deal first with a more general question which is sometimes asked, namely, " why establish an Iron and Steel Industry in South Africa at all ? " Such a question may be asked in all good faith by people who look upon South Africa as a great mineral-producing country and a country of great agricultural protentialities, and that is because it is not generally recognised, except by those who live in South Africa and make a study of its resources, that South Africa in reality has an immense industrial future, and cannot develop solely as an agricultural and mining country.

The hectic days of the mining camps have long since passed out of the picture and people to-day come to South Africa to stay. Its climate is unexcelled, the amenities of civilisation are not lacking and the general conditions of living,

once people become accustomed to them, are appreciated and in fact become appealing.

At the present time a very large proportion of our agricultural and mining produce is exported. Intensive farming is comparatively speaking not highly developed; most farming is done on a large scale and is largely dependent on rainfall. Water conservation schemes have been embarked upon by the Government and by private interests, but the extent to which this can be carried out will depend in large measure on the extent of the farmers' home market. That there are great possibilities in this direction in the future is undoubted. The country lends itself very well, generally speaking, to water conservation, and I can foresee the time when large portions of the land will be covered by numbers of artificial lakes and dams. The rainfall in South Africa, on the whole, is high, but occurs during a comparatively few months in the year, and at present a very considerable portion of that water runs into the ocean.

As an example, it may be mentioned that the barrage on the Vaal river, which has been built to supply Johannesburg with water, impounds about 13,000 million gallons, and it happens that during summer so much water comes down the Vaal river that the dam could be filled thirty times over in one month. During the dry winter months, on the other hand, the flow is often so small that it would take, at that rate of flow, many years to fill the dam once.

I mention this merely as an example of what is characteristic in South Africa and to indicate that, although it is what may be called a dry country, ample water for cultivation and for industrial development can be obtained by storage.

Raw materials of almost every conceivable kind are obtainable in the country. South Africa can, therefore, support a very large agricultural and industrial population.

In contemplating our developments in South Africa we must often look to the distant future. We bear in mind that the Union has a hinterland of immense potential wealth, which becomes more habitable as civilisation marches northwards, and which is populated by great masses of human beings whose wants are increasing as they come more and more in contact with European civilisation. We look upon the Union of South Africa as the logical country to supply these people with a considerable proportion of their wants.

Taking the British Empire as a whole, one must be struck with the fact that such a large proportion of its peoples are either uncivilised or semi-civilised. It is therefore, from the point of view of material civilisation, in a relatively undeveloped state, and considering that the desire for civilisation of these peoples is becoming a collective consciousness, which is apparent even without particularly careful observation, one must conclude that the more highly industrially developed portions of the Empire will be called upon to an increasing extent to supply the growing wants of the masses now being born into civilisation.

In contemplating this trend of events two important phases manifest themselves. In the first place we can expect that there will take place a reorganisation and redistribution of the Empire's manufacturing activities. By force of economic laws manufacturing industries will spring up and develop in localities best suited in relation to the marketing possibilities and supply of raw materials. Goods are being manufactured in South Africa to-day which ten years ago it was economic only to import. But from this it does not follow that our imports have decreased; on the contrary, they have increased considerably. This was, of course, to be expected, because the greater the earning capacity of a people the greater their purchasing power; and the greater the industrial activity, in South Africa for example, becomes, the more the demand increases for the almost infinite list of the more highly manufactured commodities which for economic reasons we cannot manufacture and which must therefore be supplied from overseas.

Secondly, it is generally realised that a redistribution of population would be desirable if it could be accomplished. While the population of Europe has passed the economic density, the population of South Africa is so small as to be out of all proportion to the size and potential wealth of the country. The white population of the Union is to-day barely one and three-quarter millions. It must be admitted that to take merely the white population in considering the economic capacity of South Africa is misleading, because the coloured and native races also have a certain economic value, although it be on the average below that of white people. Taking the economic value of the coloured and native races, as producers and consumers, in relation to that of whites, and multiplying this ratio by their population and adding the resultant figure to the white population, I estimate that what may be termed the "equivalent white" population of the Union, is in the neighbourhood of four millions. The producing man power of the Union is therefore still very far below what it should be to be commensurate with the natural resources of the country. South Africa is therefore a country that should be able to take considerable numbers of emigrants from Europe. But with the present state of its industrial development it cannot risk taking in any considerable number of the type of people that Europe would care to let go. Europe, like most countries, prefers to retain its country people, and until South Africa is more highly developed industrially it cannot absorb in any large numbers the industrial people of Europe. The solution, therefore, seems to be that a redistribution of population can only take place concurrently with bigger industrial developments in the newer countries like South Africa.

The manufacturing industry in the Union has grown at an extraordinarily rapid rate during the past ten or fifteen years. While it was an almost negligible quantity some fifteen years ago, the manufacturing industrial output of the Union is now about twice as great as the total production of wealth through mining, including gold, diamonds and coal.

It is generally recognised that an Iron and Steel Industry forms a solid foundation on which a sound industrial structure of a country must rest, and the lack of a well-developed iron and steel industry in South Africa is recognised as a hamper to our progress. The engineering industry has developed to a fairly satisfactory state, but is still capable of considerable expansion. The making of iron and steel, on the other hand, is still confined to a very small scale.

An investigation into the economic possibility of an iron and steel industry has received the attention of the Government and private interests on and off for almost twenty years without so far having attained any marked degree of success.

In 1909 a report was made by Sir Robert N. Kotze (then Mr. R. N. Kotze), the Government mining engineer, in which he advocated the building of a blast furnace and steel plant on a moderate scale, with a view to developing the use of native ores for the production of steel. Large quantities of iron ore were known to exist at Pretoria.

In 1910 the Government of the Transvaal invited a British expert, Mr. Harbord, to investigate the matter further. Unfortunately Harbord's report was negative, and he recommended that, instead of starting a blast furnace plant, the smelting of the large quantities of scrap available from the railway works should be undertaken in electric furnaces. Harbord's principal objections were on the grounds that the ores in the Pretoria district were too highly silicious to give good results, and also that the home market was insufficient to absorb the production of an iron and steel plant large enough to work economically.

At that time the very considerable high-grade haematite deposits on the Crocodile river had not yet been discovered, but apart from that, important British steel makers apparently did not agree with Harbord's views, because, in 1910-11, one of the foremost British steelmakers started negotiations with the municipality of Pretoria to establish a blast furnace and steelworks plant on the Pretoria townlands.

About that time the Transvaal Government decided, as a result of the report of Harbord, to offer for sale the large quantities of scrap iron of the Railways, with a view to encouraging the starting of a steel industry. Tenders were called for and the late Mr. Samuel Marks was the successful tenderer. The consequence was that the above-mentioned negotiations with the Municipality of Pretoria were abandoned, as it was thought impossible to carry out this scheme unless large quantities of scrap iron were available.

Having secured the Government's scrap iron, Mr. S. Marks and some others started a small steel works at Vereeniging, which later on became what is now known as the Union Steel Corporation of South Africa, under the chairmanship of Major Aubrey Butler. It should be mentioned, however, that the Dunswart Iron and Steel Works, near Johannesburg, where scrap was worked up on a small scale, was then already in existence.

Until 1917 the only practical result, therefore, was the two small steel plants at Vereeniging and Dunswart, at both of which the raw material was scrap iron only. In that year Mr. C. F. Delfos formed a small company, the Pretoria Iron Mines, Ltd., for the purpose of testing the suitability of the Pretoria ores with a view to the establishment of an iron and steel works there. He built an experimental blast furnace of a capacity of 10 tons per day, with which 4,000 tons of satisfactory pig iron was produced. As flux he used dolomite, which occurs in very large quantities practically adjoining the iron ore deposits. The Pretoria ore contains on the average 48 per cent. of metallic iron, but is highly silicious. However, the experiment proved that with the Pretoria iron ore and the adjacent dolomite suitable pig iron could be made.

As Delfos and his associates were convinced that a steel industry could only be successful if modern plant of a sufficiently large capacity were installed, it was decided to form a company with a larger capital. The Pretoria Iron Mines, Ltd., was then taken over by the South African Iron and Steel Corporation, with a nominal capital of £1,500,000, of which, however, only £350,000 in cash was raised at that time. This amount was employed to investigate thoroughly the possibilities and resources of the industry and to acquire the necessary ore deposits, etc., the result being that the present enterprise now possesses some 150,000,000 tons of ore, of which two-thirds contain an average say 48 per cent. of metallic iron and one-third some 68 per cent. of metallic iron as also large coal fields, and practically unlimited quantities of dolomite, which is suitable as flux.

Meanwhile a parallel development was started by Mr. G. K. Eaton, who had been largely responsible for the establishment and successful career of the steelworks at Dunswart. Being convinced that for the true development of the industry it was necessary to have a pig iron basis he made arrangements for the erection of a small blast furnace at Newcastle, Natal.

In 1920 Delfos went to Europe to endeavour to raise further capital and to obtain technical advice. He engaged, as adviser, Mr. Ernest Bury, who was then General Works Manager of the Skinningrove Iron Works. Bury thoroughly investigated the raw materials, and in 1921 went to South Africa. He made an entirely favourable report both from the technical and the commercial points of view. His conclusions were that although the Pretoria ores were high in silica he anticipated no trouble in producing good steel from this ore.

The conclusions of Bury's report were investigated as regards the economic factors by an auditor of high standing in the steel industry, Sir W. B. Peat, and its technical conclusions were submitted to the late Dr. Stead, then President of the Iron and Steel Institute, who consulted with Harbord. These experts corroborated Bury's finding both from the economic and technical points of view. Assurance of the technical and economic feasibility of the

undertaking having thus been obtained, it was now only necessary to raise sufficient capital. This, however, proved to be the real stumbling block.

The first attempt to raise capital was made in 1920, when the assistance of the Trade Facilities Advisory Board was asked for. This body, however, required guarantees from the South African Government which the latter was not prepared to give.

Although the exploration by Delfos of all other avenues of obtaining capital in Great Britian failed, it nevertheless resulted in negotiations with a prominent British iron and steel concern with a view to their participation in the establishment of an iron and steel works in South Africa.

It was realised that there was room for only one such works in South Africa, and the negotiations led to a provisional amalgamation of the three principal interests, namely, the Union Steel Corporation, the South African Iron and Steel Corporation, and the Newcastle Iron Works. The most important stipulation of this amalgamation was that sufficient capital must be raised to carry out the programme.

Towards the end of 1920 I returned to South Africa as Technical Adviser to the Government on industrial matters. After making a study of the economic conditions in South Africa I came to the conclusion that the industrial development which the country had attained lacked the proper foundation which, as it seemed to me, only an iron and steel industry could furnish. After discussions which I had with General Smuts, then Prime Minister, it was decided to encourage this industry with the help of bounties on the production of iron and steel from South African ores. The maximum value of the bounties amounted to fifteen shillings per ton of pig iron and an equal amount per ton of steel, a condition being that the capacity of the works should be at least 50,000 tons per year. The Bounty Act was passed by Parliament in 1922. As a result, the Trade Facilities Advisory Board was again approached, but without success. Other attempts to get the undertaking financed in London also fell through, because of unsatisfactory terms, and further efforts to obtain capital in Great Britain were then abandoned. Thereupon the South African Iron and Steel Corporation withdrew from the amalgamation.

In 1923, General Smuts, who was then in power, instructed the Union Trade Commissioner on the Continent to make enquiries whether other interests could be induced to start a steel industry in the Union. As a result of these enquiries the Government received an offer from the Gutehoffnungshuette to send out a technical commission to South Africa and, should the result of its investigations be favourable, to build and finance the enterprise in conjunction with British, Dutch, and German financial interests. The Government approved of this suggestion and put the Gutehoffnungshuette into touch with the South African Iron and Steel Corporation.

The technical commission came to South Africa early in 1924 and thoroughly investigated the whole question. Their report was entirely favourable, and it

was recommended that a plant capable of producing 132,000 long tons of finished steel should be put up at Pretoria, this being the most favourable site from all points of view.

The industry would undoubtedly have been established at that time, but unfortunately the occupation of the Ruhr made it impossible for the Gutehoffnungshuette and its associates to undertake the financing of the scheme.

It was then considered impossible to raise sufficient capital from private sources, and towards the end of 1925 Delfos made a proposal to the Union Government that they should support the Steel Industry financially, with a view to the formation of a semi-public Company.

In the meantime the Newcastle concern was absorbed by the Union Steel Corporation, the arrangement being that pig iron made at Newcastle should be taken to the works of the Union Steel Corporation at Vereeniging, some two hundred miles away, to be made into steel. The blast furnace at Newcastle which was started by Eaton was completed and blown in in 1925.

Two years ago the Union Steel Corporation claimed bounties for its production of iron at Newcastle, but the Government, not being satisfied that the capacity clause of the Act had been complied with, refused to pay the bounties. The matter went to court, which gave a decision in favour of the Company, but on appeal the decision was reversed. This unfortunate incident has caused a certain amount of bitterness, and therefore I do not regard the present occasion as appropriate for doing more than merely making brief mention of the occurrence, especially as I had no connection with it and therefore cannot speak with authority on the matter.

Last year Messrs. Stewarts and Lloyds erected a modern tube factory at Vereeniging. The steel industry at Vereeniging now comprises a steel works, where steel is made from scrap and Newcastle pig in open hearth and electric furnaces, the products being rails up to 60 lbs., the smaller sections and merchants' requirements, tube billets for the tube works of Stewarts and Lloyds, steel castings and forgings ; a wire works for the manufacture of plain and barbed wire and the above-mentioned tube works.

The Government authorities were not convinced that the amalgamation of the steel works at Vereeniging and the iron works at Newcastle was sufficiently sound economically to develop into an iron and steel industry on the national scale that was desired, and it consequently sought legislative powers to establish an iron and steel company roughly on the lines of the Electricity Supply Commission which was formed in 1923.

The Iron and Steel Bill was passed by Parliament in 1927, but was rejected by the Senate, whereupon in 1928 the Government called a joint session of both Houses at which the measure was passed. This resulted in the establishment of the South African Iron and Steel Industrial Corporation, Ltd., and arrangements were made for this new concern to absorb the South African Iron and Steel Corporation.

Although the measure was strongly contested there was little difference of opinion as to the desirability of encouraging the establishment of the iron and steel industry on a reasonably large scale. The difference of opinion lay largely in the manner in which it was proposed that the Company should be constituted, objections being raised to the Government retaining the control, while on the other hand it was held that the constitution of a company more or less on the lines of the Electricity Supply Commission was justified by the success of the latter.

Both the Commission and the South African Iron and Steel Industrial Corporation are in the nature of their constitution a departure from the ordinary. The Commission was established by the Government in 1923 in recognition of the great value of electric power in the industrial and economic life of the people, and because electric power is regarded as a prime factor in industry, the production of which should be encouraged for the benefit of industry generally rather than with a view to making profits. In the establishment of the Commission a genuine attempt was made to combine the advantages of both Government ownership and private enterprise.

The Commission is not a Government Department, but a body corporate in law and is established by Act of Parliament. All Commissioners are appointed by the Government, but their remuneration is not paid by the Government but by the Commission itself. Neither the Commissioners nor any of the Commission's employees are civil servants. The Commission is, in fact, free to operate in every respect like a private concern, the only real difference being that it must, generally speaking, be a non-profit-making concern; all surplus after meeting capital charges must go to reduction of the price of electricity.

A material advantage enjoyed by the Commission lies in the financial assistance afforded by the Government, the latter having undertaken to finance the Commission during the first seven years of its existence, that is, during the period when it would be difficult to obtain money from the public. The money loaned by the Government is a liability against the assets and revenues of the Commission.

The Commission now owns four steam power stations and one small hydro-electric power station, of a total installed capacity of nearly 300,000 h.p.; its capital commitments are about £8,000,000, while this year I expect that the sales will amount to about 800 million kilowatt hours of energy from the Commission's power plants.

The success of the Commission is due largely to the nature of its constitution. Had it been a Government department it would not have been possible for it to grow in less than six years from nothing to one of the largest power supply concerns in the Empire. On the other hand, had it not been for the financial assistance afforded by the Government it would not have been possible for us to sell electricity at the low rates obt:

I may be excused for dwelling at some length on the Electricity Supply Commission, but it is necessary because of the close analogy between it and the newly-formed South African Iron and Steel Industrial Corporation. This Corporation is also constituted by Act of Parliament and is a duly registered company. Out of a total directorate of seven, the Government appoints four directors, including the Chairman, who has a casting as well as a deliberative voet.

Its authorised share capital is £3,500,000, and it is also empowered to issue debentures to the amount of £1,500,000, thus making a total capital of £5,000,000. By the Act the Government is authorised to subscribe £500,000 out of the £3,500,000 share capital and to guarantee the one and a half million debentures in respect of both interest and principal. Besides this guarantee these debentures must also be backed by assets of the Corporation The Corporation is therefore sure of £2,000,000. The rest of the capital required must be obtained from the public.

The debentures are to pay interest at a rate not exceeding 5½ per cent. Considering the Government guarantee of the debentures and their lien on the assets of the Corporation, these debentures should be a very sound investment, and therefore a sufficient margin is allowed in the maximum interest provided for by the Act.

Of the shares, those taken up by the Government (A shares) and those to be issued to the public (B shares) share in dividend *pari passu* up to six per cent., which is the maximum dividend payable on the Government or A shares. Thereafter the public or B shares get the rest of the profit up to a maximum dividend of 12½ per cent. Any surplus that may remain after appropriation of profits in the above-mentioned manner may be applied by the Board, in such manner as it may in its discretion deem practicable, to the reduction of the price of iron and steel.

The capital of the Corporation may, with the approval of the Governor General, be increased by 500,000 ordinary B shares of £1 each.

The Board is empowered, but with the approval of the Minister in charge of the Act, to offer to the public preference shares, cumulative or otherwise, in lieu of any number of ordinary B shares, and the Board may acquire, without Ministerial approval, rights and property for payment in B shares, and is empowered to withhold the equivalent number of shares from public issue.

The debenture issue can be made at such time and amounts as may be suitable, but only with the approval of the Governor General, and a sinking fund must be established to redeem the debentures in not more than forty years. The Board, however, has power to buy the debentures in the open market and cancel them. In case the Government be called upon to meet the guarantee on the debentures, such disbursement from the Government's Consolidated Revenue Fund, together with interest at the rate of 5½ per cent., must, according to the Act, be a second charge on the assets and revenue of the Corporation.

The Board is furthermore empowered to borrow from time to time in anticipation of the issue of any shares or debentures up to the amount of such proposed issue ; it may also borrow additional sums, but then only with the approval of the Governor General, the limitation to such borrowing being one million pounds. Interest on any debenture issue during construction may be charged to capital account.

The books of the Corporation are to be audited by two auditors, a condition being that they must be persons who publicly carry on the profession of accountants. One of the auditors must be appointed on the nomination of the Minister, and the other on the nomination of the holders of B shares.

It will be seen, therefore, that where actions of the Board require approval of the Government, or the Minister, it is for the protection of investors.

The Government retains ultimate control through a provision of the Act which stipulates that although the Government buys only half a million pounds' worth of shares it shall have one more vote than the total number of votes which all the other shareholders of the Corporation may be entitled to in respect of the shares they hold Furthermore, the Corporation cannot be wound up without the authority of an Act of Parliament.

This control does not, however, imply interference on the part of the Government in the affairs of the Corporation The Electricity Supply Commission, as stated above, is a similar body. It has been in existence now for almost six years, during which time two different Governments have been in power, and as I have been chairman of the Commission since its inception, I can say with authority that I have never experienced the slightest Government interference in the affairs of the Commission, and the Government has given an undertaking in Parliament to follow the same policy in regard to the Steel Corporation. This policy of no political interference is becoming a tradition with us. The measure of Government control that exists is for the protection of the investors and for the benefit of the country.

As to the objects and powers of the Corporation, these are, as in the case of the Electricity Supply Commission, very wide indeed. They are as follows : –

(*a*) To carry on the trades or businesses of iron masters, steelmakers, steel converters, colliery proprietors, coke manufacturers, miners, smelters, engineers and iron founders in all their respective branches, and to manufacture, manipulate, buy, sell, exchange and otherwise deal in iron and steel ;

(*b*) To purchase or otherwise acquire, as a going concern, all or any part of the business, property and liabilities of any person or company carrying on any trade or business which the Corporation is authorised to carry on, and to carry on, abandon, dispose of or otherwise deal with any trade business so acquired.

(*c*) To search for, win, quarry, reduce, smelt, refine and prepare for market iron ore or any other mineral capable of use in the production or treatment of iron and steel.

(*d*) To apply for, purchase or otherwise acquire any patents, licences, concessions or the like, conferring an exclusive or non-exclusive or limited right to use any information or process which may seem to the Corporation capable

of being used for any of its purposes, or the acquisition of which may seem to the Corporation calculated, directly or indirectly, to benefit the Corporation, and to use, exercise, develop, grant licences in respect of, or otherwise turn to account the property, rights and information so acquired.

(*e*) To acquire and take over rights and liabilities under any control relating to the production or treatment of iron or steel or any other mineral capable of use in the production or treatment of iron or steel.

(*f*) To investigate and prospect with a view to the discovery of deposits of iron ore or any other mineral capable of use in the production or treatment of iron or steel, and to enter into options, contracts and other arrangements for the acquisition of rights to prospect, open up and mine such ore or any such minerals.

(*g*) To take or otherwise acquire and hold shares or stock or securities in any company having objects wholly or in part similar to those of the Corporation.

(*h*) To sell, exchange, lease, mortgage, dispose of, turn to account or otherwise deal with any assets of the Corporation, or any part thereof, or any part of its property, whether movable or immovable, not required for the purposes of the Corporation, for such consideration as the Corporation may think fit, and in particular for shares or debentures, debenture stock or other securities of any company having objects altogether or in part similar to those of the Corporation; and

(*i*) To purchase and sell coal or fuel, steam, water and other materials and stores, and manufacture and sell by-products.

In connection with the attainment of any objects of the Corporation referred to above, the Corporation may-

(*a*) Purchase, take on lease or in exchange, hire or otherwise acquire any movable or immovable property, claims, mineral properties, mining rights, water and other rights of every description within the Union, and any interests therein and rights over the same, and any concessions, grants, rights, powers and privileges in respect thereof, and may act as aforesaid either solely or jointly with others; and

(*b*) Carry out, establish, construct, maintain, alter, improve, manage, work, control and superintend any roads, ways, railways other than for the conveyance of public traffic, bridges, reservoirs, water courses, pipe lines, embankments, hydraulic works, electrical works and chemical works, telephones, smelting works, furnaces, factories, warehouses and other buildings, works and conveniences, and contribute to or assist in the carrying out, establishment, construction, maintenance, alteration, improvement, management, working, control or superintendence thereof: provided that any railway sidings constructed and worked under the provisions of this sub-section, and connected with the lines of the South African Railways and Harbours Administration shall be subject to such regulations as have been or may be promulgated under the Railways and Harbours Regulation, Control and Management Act (Act No. 22 of 1916), or any amendment thereof, in respect of private sidings.

The Corporation may further do all such other things as are incidental or conducive to the attainment of any object or incidental to any powers or functions mentioned in this section, or which are calculated directly or indirectly to enhance the value of or render profitable any of the Corporation's undertakings, property or rights.

These wide powers given to the Corporation caused the Board to be faced at the outset with a very important question of policy, namely, the scope of operations that we should aim at. My interpretation of the Government's policy which put the Iron and Steel Industry Act on the statute book is that it was not the intention to bring into being and assist financially a powerful corporation for the purpose of competing with existing industries in the country, but, firstly, to contribute in a very substantial measure towards building the foundation of our engineering and other industries by the establishment of the basic industry, namely, the manufacture of iron and steel, in recognition of the experience that the manufacture of iron and steel in a country has a powerful influence in stimulating industrial growth generally, and, secondly, to ensure the development of subsidiary industries should private enterprise fail to follow in the wake. We therefore decided as a fundamental principle of our policy to confine our efforts, as far as practicable, to the production of primary steel products, such as rails, sleepers, building sections, sheet bars, light plate, billets, ordinary merchant requirements, and reinforcement and wire rod, believing that where opportunity offers for the development of subsidiary industries private enterprise will not fail to seize it. We are of opinion that the best results will be obtained by working amicably together with subsidiary and cognate industries and by encouraging the establishment of further subsidiary industries. It will certainly redound more to the benefit of the Steel Corporation if our efforts are directed towards assisting capital which has been invested in such industries to earn more and so to encourage further development. Thus, although the Corporation has secured coalfields, it would be wiser to purchase coal from existing collieries as long as satisfactory terms can be obtained rather than sink more capital into new collieries for the sake of mining our own coal. It will be seen that I keep in sight the national aspect, which, especially in a country like South Africa, it is very important to do. The iron and steel industry can only prosper with the general prosperity of the country, and, while this is generally true of many other industries, in the case of iron and steel this truth looms up with much greater reality because of the basic nature of the iron and steel industry. One of the best means of encouraging prosperity generally is to enable already invested capital to increase its earnings and to guide industrial development in such a manner as to avoid as far as possible fruitless duplication of capital expenditure.

As a result of this general policy, we have laid the foundation of an amicable working agreement with the Union Steel Corporation whose works are at Vereeniging and Newcastle. With this, it is hoped, the conflict of steel interests, which existed for years, has now come to an end.

As regards the technical and commercial possibilities of the undertaking our investigations give reason to be hopeful of success.

It is proposed to establish the iron and steel works at Pretoria. The ore

deposits which influenced Mr. Delfos some twelve years ago to erect the experimental blast furnace mentioned above occur mostly on the Pretoria townlands some four miles from the centre of the town.

The Corporation has a 99 year agreement with the Pretoria town council, whereby the site for the iron and steel works is obtained free of cost, and the ore can be mined at a royalty of £500 per annum or 2d. (two pence) per ton, whichever is the greater. Provision is also made for the supply of water by the town council on favourable terms.

The Pretoria ore quantities are estimated to be about one hundred million tons of silicious haematite, yielding about 48 per cent. metallic iron and about nine million tons of claybound ore averaging 54 per cent. metallic iron.

For many years the silicious ore will be quarried in the hillside adjoining the works. Other iron ore resources include a deposit of roughly fifty million tons of extremely pure haematite of about 68 per cent. iron. This deposit occurs on the Crocodile river about 115 miles north of Pretoria and for many years can be obtained by quarrying and adit mining.

The coal resources of the Union of South Africa are estimated at about 250 thousand million tons. The coal occurs mostly in the Eastern Transvaal and Natal. The Natal deposits contain several seams of excellent coking coal and is comparatively easily mined, but the distance of these coal mines is over 200 miles from Pretoria. The Transvaal coal mines (in the Witbank area) are about 60 miles from Pretoria on the Pretoria-Delagoa Bay main line, and while this coal does not appear to have the same good coking qualities as the Natal coal it is nevertheless possible that the whole or at least a very considerable proportion of the coal required for the steel works will be drawn from the Transvaal coal fields.

The dolomite required for the blast furnaces occurs in very large quantities a few miles from the site and will be brought to the works on a ropeway, while lime for the steel furnaces is also obtainable in the Transvaal.

It is proposed to lay out the works for an initial annual production of about 150,000 tons of steel. This would be about half of the importations of the materials we propose to make. It is our intention to design the works in such a manner as to be capable of easy extension, because once successful, we can expect it to grow rapidly if it is to keep pace with the general economic growth of the country.

In this connection I may mention that the total exports of the Union during the past five years have increased by 75 per cent. This gives an indication of the growth of the country's trade.

DISCUSSION.

The Chairman, in opening the discussion, said that one thing which had particularly struck him had been that the lecturer was approaching his great responsibilities with a very high sense of industrial statesmanship; he had said

that the iron and steel industries could only prosper with the general prosperity of the country, and had also pointed out that the iron and steel industry was the foundation stone of a modern industrial community. It was, indeed, his personal opinion that an industrially prosperous country was only possible if it had an efficient iron and steel industry. In establishing an iron and steel industry in South Africa the lecturer would, he was sure, not force the pace so fast, that the prosperity of that great country, with its most wonderful resources yet untapped, was affected or delayed by reason of the fact that the materials necessary for development, in the form of iron and steel products, were not available at an economic price level. Mistakes like that had been made in other parts of the world, which had not only had a very detrimental effect on the territories themselves, but also on the development of mutual trade within the Empire.

As representing, in some sense, the British iron and steel industry, he might be permitted to say that that industry followed the development which had been outlined that afternoon with the greatest sympathy, and in a spirit of the closest co-operation, which the South African iron and steel industry would permit. They did not look on these developments within the Dominions as in any sense competitive, although they might ultimately or immediately reduce to some extent the demands made upon their productive capacity. Taking the long view, he was confident that such developments would increase the demands, ultimately, which the Dominions would make on British industrial products, and even on the products of the British iron and steel industry itself So long as the views which the lecturer had expressed so ably and eloquently that afternoon governed the industrial policy of South Africa with regard to her iron and steel industry, then he was confident that the development of South Africa would not be retarded by the foundation of that industry, but would be accelerated. He would like to assure the lecturer that he had only to indicate to the British industry any way in which which they could co-operate, and he was confident, speaking for them, that that co-operation would be forthcoming. Personally, he looked on industries of a like kind developed throughout the Empire as having like interests, and he hoped that the British industry would always treat their development as being one of absolutely common interest and developing a common market to each other's mutual advantage. It would be noted that the exports of South Africa had increased 75 per cent. in the last five years. Where did they go to? Seventy per cent. came to this country. South Africa being in the family, as it were, all would contribute as much as lay within their power to the development of her resources, believing that in so doing they were also serving their own best interests.

Mr. F. W. Harbord, C.B.E. (Past President of the Iron and Steel Institute), said they all greatly appreciated the opportunity of hearing a lecture which had given so much information on the recent discoveries of raw materials, and the present economic position of the iron and steel industry in South Africa. It had been his privilege to visit South Africa about eighteen years ago to report to the then Transvaal Government on the possibility of starting an iron and steel industry there. An iron and steel industry, or any other industry, depended for its success mainly upon two things—firstly, control of adequate supplies of suitable raw materials at a reasonable price, and, secondly, a market for the finished products. Eighteen years ago there were undoubtedly raw materials in South Africa from which pig iron could be made, but he had been forced to the conclusion, after most careful consideration, that the market in those days was not sufficient to enable a steel works to be operated at anything like its full capacity, and consequently

the erection of a large steel plant was not then justified. Nearly twenty years. however, was a long time in the life of a country and great progress had been made in South Africa during that period. He understood that the imports of the whole of the Cape had trebled during the last eighteen years, and that new deposits of iron ore, relatively low in silica and easily reducible, had been discovered quite near Pretoria. A new deposit of coking coal had also been discovered, and the use of dolomite, of which there were large quantities in South Africa, as a flux had been shown to give perfectly satisfactory results in the manufacture of pig iron in various parts of the world. Therefore, to-day, conditions were totally different to those prevailing eighteen years ago, and he believed the time had now come when an iron and steel industry could be successfully started in South Africa, provided a plant of moderate size were installed, and gradually increased as the demand for its products increased. South Africa enjoyed the natural protection for iron and steel products of a long sea freight and for the Transvaal and the rapidly-developing country to the North a railway freight of 600 miles, and these, apart from any bounty or assistance which might be given by the Government, formed a great natural protection to the market. The country generally was developing rapidly, and there was a great and increasing demand for many of the finished products of the iron and steel industry. Under those conditions it seemed to him that the only thing South Africa could do was to try to develop her own iron and steel industry, and he looked forward to seeing an industry successfully established in the near future.

Before closing he would like to refer to the pioneer work done by Mr. Delfos, and express his appreciation of the indomitable pluck and perseverance he had shown, extending over many years. It was undoubtedly largely due to his untiring efforts that South Africa had decided to establish an iron and steel industry.

Mr. J. C. Fraser mentioned that he had been connected with South Africa for fifty years and could therefore claim to speak with a certain amount of authority on the questions which the lecturer had brought before the meeting that afternoon. He had attended in order to get information as to where this gigantic State monopoly was to find an outlet for its manufactured goods. The lecturer had made one or two statements with which he entirely disagreed. The first one was that South Africa was bound to be a good agricultural country. One only had to study the history of the last twenty-five years, during which time agriculture had had the best possible care bestowed upon it by all the Governments which had been in power, to admit that the future of South Africa, as far as the Union was concerned, did not lie in agriculture. If South Africa was not going to be an agricultural country, where was the outlet going to be found for the products of this proposed industry? Something had been said about the huge development of industry in South Africa of late years. It was quite true that the country had gone ahead wonderfully, but it had done so behind the shelter of high tariffs which had been put on practically everything coming into the country. In his opinion a great market for the products of an iron and steel industry in South Africa was merely a dream. As far as he could see, the great future for South Africa lay in the development of its minerals. If half the stories were true as to the wealth of Rhodesia in copper, they were going to " lick creation." The lecturer had entirely failed to state where the markets for his iron and steel industry were going to be found.

He contested entirely the lecturer's idea of assessing, as he had done, the value of the black population. There was a mere handful of white people in South Africa

to-day; the Union contained 1,750,000 white people. What a market for which to start an iron and steel industry! Was there any chance of the black people being any good for the purpose? There was none, as the whole policy of the Government at the present time was to keep the black man from earning money; they were anxious to segregate him, and how could any efficient demand be hoped for from poor people like that? The truth of the matter was that the whole of the labour and social policy of the Union to-day was founded on the black man's cheap labour, and as for an iron and steel industry being of any use to the natives, he could not see it at all. What he would like the audience to clearly understand was that the project was going to be a State venture. A great number of people in South Africa did not believe in State manufacture. They had seen a good deal of it during the last ten years, and the more they saw of it the less they liked it.

Sir Benjamin Morgan (Chairman, British Empire Producers' Organisation), remarked that there had been a good deal of criticism of the project under discussion, but personally he was convinced that a steel industry could be successfully established in South Africa. He had known South Africa fairly intimately for about twenty-five years, and he thought that, providing the industry did not spread itself over too wide a field, it could engage in steel manufacture with great success. Personally, he believed that Empire development would proceed very much quicker than it had in the past if all concerned co-operated in the distribution of industries throughout the Empire. For instance, if South Africa said to Great Britain: "You co-operate with us to found this industry, limiting it to certain kinds of products, and we, in our tariff, will give you a substantial preference in all the other ranges of steel products," far more business would be done with South Africa than was done to-day. The right policy for the Dominions was to produce certain commodities which they could economically produce, and it would be the right policy for this country to support the Dominion's efforts to found those basic industries in their own countries.

He had been very much surprised at the gloomy picture which the last speaker had painted as to the development of industries in South Africa. As a matter of fact, the South African primary industries were going ahead very rapidly. For instance, the export of sugar from Natal to this country had grown from 5,000 tons four years ago to 75,000 tons this year. The wine, fruit and wool industries were expanding in the same way. That was a very promising feature in relation to the establishment of an iron and steel industry in South Africa. The only thing he would like to be sure about was that that industry would come to this country and not go elsewhere for technical guidance and co-operation. It would get better value for its money here than in any other country.

Mr. C. F. Delfos said the impression he had gained from Mr. Fraser's speech was that Mr. Fraser was absolutely misinformed about the position. There was no doubt that South Africa had an entirely sufficient market for the material which it was intended to produce from its iron and steel works. The position was a very good one. Pretoria was inland, and there was a great protection afforded by reason of the distance from other iron and steel producing countries. There was no doubt that the market was there. For instance, there was a demand for 60,000 tons of wire per year in South Africa; in corrugated galvanised sheets there was a demand for 63,000 tons, and for steel rails and sleepers there was a demand for about 100,000 tons. In other sections the demand was also large. South Africa for the next one or two generations would not be a true industrial

country in the sense in which that was understood here, but if she could start to produce her raw materials in such a way as to develop the country, the buying power of the population would become very much greater, and the effect would be that a very much greater quantity of goods would be sold. He was afraid that Mr. Fraser did not know what the true position was. Success would follow the venture, which had been described in the paper, under the able guidance of the lecturer.

MR. FRANK COOPER said that, speaking as one who some years ago had had the good fortune to be associated with Mr. Delfos in his investigations, he would like to point out that one phase of the matter had not been touched upon—owing no doubt to the modesty of the lecturer and of Mr. Delfos. Those gentlemen had remarked on the length of time that the scheme had been under consideration, but they had not said anything about the immense amount of labour and thought which they had put into the project. He had worked with Mr. Delfos for several years, and had been amazed at the amount of care and thought with which he had examined every item of the scheme. By now the lecturer and Mr. Delfos must be walking encyclopaedias of everything that had happened or was happening in the iron and steel industry of the world, and when the proposed plant was opened he was perfectly satisfied that it would not only be a credit to South Africa but a credit to the Empire.

MR. A. K. REESE stated that he had had some experience in connection with the iron and steel industry in South Africa in connection with the Union Steel Corporation, and from the technical side of the matter he could fully confirm everything which the lecturer and Mr. Delfos had said. The country had resources which were eminently suitable for the manufacture of best qualities of iron and steel. There was an abundance of good iron ore and good coking coal in the country, and there was no reason at all why the industry should not develop and be the basis of the establishment of other important industries. The only precaution which had to be taken was to see that at the start a too large industry was not established which would choke itself with over-production, but that point could be safely left to the lecturer, to Mr. Delfos and to others interested.

MR. E. J. FOX said he had attended the meeting as a slight compliment to Mr. Delfos, to whom the greatest thanks were due for the extraordinary perseverance he had brought to bear on the subject, extending over so many years. It was unquestionably the bounden duty of South Africa, with the immense mineral resources which she had available, to develop those resources. South Africa had labour and minerals, and could anyone blame her if she employed her labour in the development of her own minerals?

DR. J. A. L. HENDERSON said that the subject was one which had occupied a good deal of his time some thirty years ago on behalf of the late Mr. J. C. A. Henderson, who was an enthusiastic believer in the possibility of establishing an iron and steel industry in South Africa. Much money was spent on the investigation of various iron ore deposits, limestones and dolomites; the coking qualities of the coals, water supplies, and the markets for iron and steel products; but, unfortunately, for the reasons adduced by Mr. Harbord, the consensus of expert opinion which had been obtained in England and elsewhere, justly negatived the possibility of success in those days. It was, therefore, with great interest that he

had heard that afternoon not only of the recent rapid expansion of South Africa's industries, and of its power of consumption of iron and steel products, but of the figures which had been given with regard to the effective employment of the dolomites as fluxes, which had seemed to offer an insuperable obstacle thirty years ago, and also the profitable utilisation of the abundant titaniferous iron ores which had also been considered to be unsuitable for the purpose in past days.

The chief criticism, which many made in regard to a project of the nature under discussion, was as to whether the form of direct Government association with an industry was the best one under the circumstances. Many favoured a bounty rather than such an association. He had been interested in noting the struggling position of the iron and steel industry in Nova Scotia, Canada, where there was access to abundant supplies of excellent iron ore, with plentiful and suitable limestone and good coking coal in the immediate neighbourhood; and one wondered how the South African industry would eventually work itself out.

In view of the great advantages which would accrue to South Africa from its success, the progress would be followed with keen and sympathetic interest.

LIEUT.-COLONEL ALAN DORE, D.S.O. (Director, Messrs. Baldwins, Ltd.), said he had recently returned from South Africa, where he had heard people talking about the project described in the paper. A good many were in favour of it, and a good many were against it. One of the things he had heard said was that if the country produced 150,000 tons of steel out of the 300,000 tons imported, it would have to make everything practically from twist drills to bicycles, and it was argued that that would not be cheap production, as only a few tons of one article and a few tons of another would be made, and consequently the cost of production would be very high. Another criticism which had been passed was that there was no water in Pretoria. The most serious objection he had heard was that the project would be a State monopoly.

THE LECTURER, in reply, dealing with the point of manufacturing 150,000 tons of steel when the importation was only 300,000 tons, said that what the proposed works were going to make was not 50 per cent. of electrical machinery, needles, drills, and so on, but 50 per cent. of the present importation of 300,000 tons of rails, sleepers, building sections, galvanised sheets, wire, reinforcement rod and so on. They were only going to make 150,000 tons of those things. The whole question of markets, production and economic output had been thoroughly gone into. They would not have to look for a market. It was there. The country did not stand still. By the time the works would have reached the producing stage, say, three years hence, the present figure of importation would probably have gone up by 40 per cent., which would make it still more easy for the works to dispose of its proposed production of 50 per cent. of the present importation.

With regard to water in Pretoria, that had been a difficult problem. It was not so much a question of no water as of too much water. But the water was to be supplied by the Pretoria Town Council, who had got out several schemes, and their only difficulty was to decide which one to adopt. He anticipated no difficulty in getting all the water required for an iron and steel industry. With regard to the question of State monopoly, he had dealt with that in the paper. He appreciated very much indeed the remarks which had been made about co-operation. It was really one of the most important, if not the most important, question which faced them that they should not try to cut each other's throats and that they should not try to make more than they could absorb. It was necessary to feel the way,

and that was exactly what they proposed to do. South Africa wanted Great Britain to understand what she firmly believed, that the development of an iron and steel industry in South Africa was going to redound to the benefit of the industries in England. There was no doubt about it. Affluence would come to the people of South Africa, and they would consequently buy more goods. Although South Africa manufactured now more than they did ten years ago she still imported more; she was one of Great Britain's best customers. It was his earnest desire to co-operate with this country, and he did appreciate very much the fact which had been expressed that afternoon that this country, too, desired to co-operate with South Africa.

MAJOR SIR HUMPHREY LEGGETT, R.E., D.S.O., in proposing a very hearty vote of thanks to Sir William Larke for presiding, and to the lecturer for his extremely interesting lecture, said if there was one impression more than another which had been left on the mind of a layman like himself as a result of the meeting it was that the lecturer had put the position with such extreme frankness that it was bound to remove any misconceptions which had been prevalent in this country, and was an indication of the way in which the South African Government and those responsible intended to carry out this great project. They were carrying it out in the light of day. There was nothing so dangerous as the growth of a spirit of distrust and the feeling that there was some political motive behind a matter which should be purely industrial. Nothing could be more typical of the spirit in which the whole matter was being approached on both sides of the water than that there should be on the same platform at the same time two men like the lecturer and Sir William Larke offering co-operation to each other in the most obviously sincere manner, and desiring to work not only for the good of their respective countries and of the British Empire, but for one of the greatest industries of the world.

The vote of thanks was carried unanimously, and the meeting terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, APRIL 2..Transport, Institute of, at the University, Bristol 5.40 p.m. Annual General Meeting

WEDNESDAY, APRIL 3..Analysts, Society of Public, at Burlington House, Piccadilly, W. 8 p.m. (1) Messrs L. H. Lampitt, F. B. Hughes and H. S. Rooke, "Furfural and Diastase in Heated Honey." (2) Mr J. W. Haigh Johnson, "Further Notes on Methods of Sewage and Water Analysis: Anti-Oxidation, and Stabilisation of Pollution." (3) Messrs B. J. F. Dorrington, and A. M. Ward, "Potassium Cyanate as a Reagent for the Detection of Cobalt."

THURSDAY, APRIL 4..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Major G. H. Scott, "Airship Mooring and Handling."

Linnean Society, Burlington House, W. 5 p.m.

FRIDAY, APRIL 5..Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Meeting of Meter and Instrument Section. Mr. F. W. Hill, "Some Technical Considerations Concerning Power Factor in relation to Tariffs."

Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. "Production of Graham-Paige Cars." (Technical Film)

Mechanical Engineers, Institution of, at the Chamber of Commerce, Birmingham. 7.30 p.m. Wing-Commdr. T. R. Cave-Browne-Cave, "Aircraft Engineering in its relation to Mechanical Engineering."

Transport, Institute of, at the Midland Hotel, Manchester. 6.30 p.m. Mr. D. R. Lamb, "Sidelights on the Transport Problem."

At Leeds. 7 p.m. Annual General Meeting.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

NEXT WEEK.

WEDNESDAY, APRIL 10th, at 8 p.m. (Ordinary Meeting.) G. H. NASH, C.B.E., M.I.E.E., European Chief Engineer, International Standard Electric Corporation, "Some Modern Aspects of Electrical Communication." SIR RICHARD A. S. PAGET, BT., will preside.

FRIDAY, APRIL 12th, at 4.30 p.m. (Indian Section.) A. T. COOPER, M.Inst.C.E., M.Cons.E., "Recent Electrical Developments in India." SIR STANLEY REED, K.B.E., LL.D., will preside.

Tea will be served in the library before the meeting from 4 o'clock.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, FEBRUARY 8TH, 1929.

VICE-ADMIRAL SIR HERBERT W. RICHMOND, K.C.B., Commandant, Imperial Defence College, and late Commander-in-Chief, East Indies Squadron, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said that Sir Edward Headlam spent a large part of his life in the Indian Marine, and during the last six years had been Director of that Service. He would not raise any blushes on Sir Edward's cheeks by referring to his services during the War, beyond saying that they had been very distinguished, and that the work he had done both during and since the War had been of great value and importance to India and the Empire. He desired to take the opportunity of acknowledging the great debt which he himself, during the time he had been Commander-in-Chief in the East Indies, owed to

Sir Edward Headlam for the manner in which he had assisted him in everything which had had to be done. Nothing could have been more admirable, and nothing could promise better, than the co-operation of the various services of the Empire at that time Sir Edward Headlam had placed the Marine at the service of the Squadron on every possible occasion on which he had been asked to do so. It had been a most pleasant duty to work with him, and the pleasure which he had had in working with him in those days he was sure those present would have now in listening to what Sir Edward had to say.

The following Paper was then read:

THE HISTORY OF THE ROYAL INDIAN MARINE.

By Captain Sir E. J. Headlam, C.S.I., C.M.G., D.S.O., R.I.M.,
Late Director, Royal Indian Marine

At the commencement of this paper I should like to make it clear exactly what has been meant by the Indian Marine Service in the past. In England to the vast majority of people India is still but little known, and it is only natural that people should know still less about the smallest of all the Indian Government Services, in fact, it is no exaggeration to say that even in India itself a great many people do not know what were, and what now are, the functions of the Royal Indian Marine. There is also among those who do know something of the history of India a tendency to consider that the days when the Service was called the Indian Navy was its chief period of activity. It certainly was a glorious period of its history, as it included participation in wars in Burma, China, New Zealand, the Sepoy revolt in India and the Persian War But the actual period during which the Service was called the Indian Navy was only 33 years

By Indian Marine, for the purpose of this paper, I include the history of the Sea Service under whatever British form of Government obtained in India from the year 1612 until the present day, under the various titles it has been called at different periods

The Sea Services under the Government of India have been known by varying titles since their first conception in 1617. Thus from 1612 to 1686 the Service was known as the Honourable East India Company's Marine, from 1686 to 1830 as the Bombay Marine, from 1830 to 1863 as the Indian Navy, and from 1863 to 1877 again as the Bombay Marine. In 1877 the title was altered to that of Her Majesty's Indian Marine, and this title lasted until 1892, when the present designation of Royal Indian Marine was finally adopted. The full title of the Service is His Majesty's Royal Indian Marine Service, but as this is rather ponderous for ordinary use it is called generally the Royal Indian Marine.

The opposition and annoyance caused to the East India Company by the Dutch, the Portuguese, and the pirates of the western coast, were the primary cause of the establishment of Naval Forces in India, of which the earliest

representative may be said to have been Captain Thomas Best, with his two ships, *Dragon* and *Hoseander*. These two vessels, together with others which arrived subsequently, reached Surat in 1612, and were engaged for three years in the almost continuous warfare which culminated in the grant by the Emperor Jahangir to the East India Company of a firman, authorising the English to trade within his dominions. The Marine forces, which at this date (1615) consisted of ten armed grabs, or gallivats, formed the original nucleus of the Bombay Marine, and up to the year 1668 were engaged in a practically unintermittent and, on the whole, successful struggle with the Company's foes both along the Indian coast and in the Persian Gulf. In 1659, the year following the cession of Bombay by the Crown to the Company and the appointment to the Deputy-Governorship of Captain Young of the Marine, a further development took place in the construction at Bombay of small armed craft for the defence of merchant-vessels trading with the ports of the Persian Gulf and the Arabian Sea. Among other vessels, two small brigantines are recorded as having been built by Mr. Warwick Pett, who was a descendant of Sir Phineas Pett, the famous shipwright of Elizabeth's reign, and who had been despatched to Bombay for this purpose with a full supply of marine stores and equipment for ship-building.

The construction of these ships at Bombay, about 1670, may be regarded as the earliest step towards the withdrawal of the Marine from Surat to the island of Bombay, which lent the name by which it was distinguished up to 1829, and which to the present day serves as its headquarters. The Marine played a regrettably conspicuous part in Captain Richard Kegwin's infamous mutiny at Bombay in 1683; for the officers and crews of the *Revenge* and the *Hunter*, both being vessels of the Bombay Marine, threw in their lot with the rebels, Captain Alderton, of the *Hunter*, being one of the four ringleaders to whom a pardon was not granted under the Royal Commission of August 24, 1684. As a set-off, however, against these disloyal acts, it is to the credit of the Service that the final surrender of the island was obtained by Sir Thomas Grantham, an officer of the Company's Marine Forces.

Under the Royal Commission which dealt with this mutiny Sir John Child, the President of Surat, was appointed Captain General and Admiral of the Company's land and sea forces, with Sir Thomas Grantham as Vice-Admiral, and the senior Captain of the Company's ships as Rear-Admiral, the three thus becoming the earliest official heads of the Indian Marine Service. In the following year (1684) Sir John Wyborne was appointed Vice-Admiral and Deputy Governor of Bombay; and in 1686 the seat of the Company's Government was transferred from Surat to Bombay, the marine stores being located in the Castle, and the Company's ships being anchored in Bombay harbour.

The Marine suffered to some extent from the spirit of insubordination and dissatisfaction which characterised the closing years of the seventeenth century. In addition to the notorious wave of sickness which afflicted all classes at this

period, considerable reductions were made in the strength of the marine establishment, particularly during the administration of Sir John Child; and these two circumstances, in combination with other minor causes of dissatisfaction, gave rise to frequent desertion.

Matters, however, improved after the transfer of the seat of Government to Bombay; the marine forces became officially known as the Bombay Marine; an officer was regularly appointed Admiral every year; and the supply of men to both higher and lower ranks was maintained by drafts from Europe. These arrangements were indeed rendered absolutely essential by the need for protecting the island against the attacks of pirates, and by the fact that the Company had still to make headway against the superior maritime forces of the French, Dutch and Portuguese. Desertion too was still an evil to be reckoned with for several years to come, and culminated in 1724 in an order to hold the pay of all seamen two months in arrears, in the hope that this would act as a deterrent.

The first notable action fought by the Marine after its re-constitution was the siege of Gheria, the stronghold of Angria, in 1717 In the previous year the total strength of the sea forces consisted of one ship of 32 guns, 4 grabs mounting from 20 to 28 guns, and 20 grabs and gallivats carrying from 5 to 12 guns apiece, but in spite of this by no means inconsiderable armament, Angria's stronghold proved impregnable and Commodore Berlew had perforce to raise the siege. On the 5th November, 1718, the Marine laid siege to Kenery the force being under the command of Manual de Castro, whom the President, much to the annoyance of the English Captains of the gallivats, had appointed Admiral of the Fleet. It was no doubt partly on this account that the President had to engage volunteers for the attack, promising that the widows and children of any who lost their lives should receive respectively £30 and £10 apiece. The attack failed in spite of the bravery of Major Stanton and others, and it was in consequence of this ill-success that the President decided to add to the fleet " a floating-castle or a machine that should be almost cannon-proof." " This vessel," writes Downing, " was pretty flat, flowed with little or no bilge and but six-foot hold. The thickness of her sides was made by the nicest composition cannon-proof She was to go with one mast and a top sail which was rigged in a very commodious manner, and mounted 12 guns carrying 48 pounders." This machine proved of very little service and was shortly afterwards destroyed as worthless. Four years later (1722) the Bombay Marine made a joint expedition with the Portuguese against Alibag, the latter providing the land force, the naval force consisting of three ships under Commodore Mathews.

A contemporary writer, alluding to the ill-success of the expedition, remarks that " the Viceroy of Goa with much pretended zeal came in person, designing to head such forces as he had raised, and the General of the North also came down to Bombay, and was most magnificently entertained by the President."

But on the day of the attack "the Viceroy of Goa went on board his ship, pretending that he was very ill. The Commodore sent his own doctor to offer his services and supply him with such medicines as should be convenient for him, if he was really ill. But the doctor returned and reported to the Commodore that he did not perceive anything to be the matter with him." The timidity, if not treachery, of the Portuguese Viceroy communicated itself to his troops and turned a well-timed attack into complete defeat, and the only satisfactory feature of the engagement was the behaviour of the Marine forces, which lost many officers and men.

During the early portion of the eighteenth century the position of Bombay, menaced as she was by the Portuguese, Sidis and Marathas, was so insecure that the Bombay Council spared no pains to enhance the value of the Marine both by improving the morale and numerical strength of the men and by increasing the fleet. Thus in 1731 the Court of Directors approved of a scheme of pensions for the widows of officers and seamen who had performed distinguished service; they indented largely upon their trading vessels for the manning of the warships; they purchased new vessels, notably the *Rose* galley in 1733, for Rs. 14,000; and in 1733 they brought down from Surat Lavji Nasarwanji Wadia, the Parsi ship-builder, who selected the present site for the Government dockyard. The Marine charges at that date amounted to Rs. 1,81,000 a year, and the fleet comprised, in addition to several gallivats and boats, seven large warships, namely the *Victoria* (frigate), the *Neptune* (grab), the *Prince of Wales*, the *King George*, the *Princess Caroline* and the *Rose* (all galleys), and the *Salamandar* (bomb ketch) Between 1739 and 1741 continual additions were made to the fleet under the auspices of Lavji Nasarwanji, as, for example, two 90-foot grabs, carrying 20 guns, and a 90-foot "sea-going ship" carrying 11 guns in a line, so that by the end of 1741 the Commodore was able, after inspection of the fleet, to report that the vessels were "entirely clear and in a proper posture for defence," and that the total strength of the fleet was:—One ship of 44 guns, 4 ships of 28 guns, 4 ships of 18 guns, 6 bomb ketches, and 20 large gallivats, manned altogether by 100 officers and from 1,700 to 2,000 seamen. Among the salient events of this period with which the Marine was directly connected may be mentioned the defeat of Sambhaji's fleet at the mouth of the Rajapur river by Commodore Bagwell and four cruisers on the 22nd December, 1738; the conclusion, by Captain Inchbird of the Marine, of a treaty with the Maratha General Chimnaji Appa on the 12th July, 1739; and the complete loss with all hands of three fine grabs, commanded by Captains Rigby, Sandiland and Nunn, in the terrible storm of the 9th November, 1739.

Discipline in these days was no easy matter. The ships were chiefly manned by British sailors, many of whom had been released from jails on their promising to serve, and a considerable number were deserters from British and other European vessels.

The year 1742 being void of "alarums and excursions," the Bombay Council decided somewhat prematurely to reduce their Marine establishment. They abolished the post of Admiral and contented themselves with a Superintendent, eight Commanders, one of whom was styled Commodore, three First and four Second-Lieutenants, four third officers and six masters of gallivats, together with a certain number of midshipmen. The immediate outcome of this action was that the mercantile fleet, now larger than ever, suffered serious losses at the hands of the pirates; while in 1744 after the declaration of war between England and France, when two French privateers were hovering off Bombay to intercept the East Indiamen, the only protective measures they could adopt were the equipment of three ships of inferior strength and the despatch of six fishing-boats to give the alarm to any English vessel approaching Indian shores.

Two notable events mark the close of the first half of the eighteenth century, namely, the mutiny on board the *Bombay*, in 1748, and the completion of the first dry dock (now the upper Bombay Dock), in 1750. The former event occurred while the *Bombay*, commanded by Captain Rough, lay at anchor off Rajapur. The mutineers attacked their officers while at supper, overcame them and placed them under an armed guard; but being wholly ignorant of navigation, and having nearly wrecked the vessel on a lee-shore, they were persuaded to return to duty on condition of receiving a free pardon, Rs. 200 in cash, and a free passage to England. These terms were carried out in all cases except those of Surgeon William Wills and four seamen. The former, convicted by a court-martial of exciting disaffection, was paraded through the fleet with a halter round his neck and hanged; and the latter had to submit to a severe public flogging. The dry dock previously mentioned was completed in 1750 and was the first dry dock in the East, and is still in regular use.

At the commencement of 1756 a Royal Naval Squadron, under Vice-Admiral Watson, visited Bombay for the first time since the island had become the property of the Company. Taking advantage of this circumstance, a combined military and naval expedition was despatched from Bombay against Vijayadrug, the stronghold of the pirate Tulaji Angria. The military forces consisted of 800 European soldiers, 300 Topasses, and 300 Sepoys under Colonel (afterwards Lord) Clive; while the naval forces comprised *H.M.S. Kent* (the flagship, 75 guns), *H.M.S. Cumberland* (flagship of Rear-Admiral Pocock, 66 guns), *H.M.S Tiger* (60 guns), *H.M.S. Salisbury* (50 guns), *H.M.S. Bridgewater* (20 guns), and *H.M.S. Kingfisher* (16 guns), and the Bombay Marine ships *Protector* (Commodore James, 44 guns), *Revenge* (28 guns), *Bombay* (28 guns), *Guardian* (28 guns), *Swallow* (16 guns), together with the bomb vessels *Drake, Viper, Triumph, Warora* and *Despatch.* On the latter were embarked a company of artillery under Captain Torey and the fleet was further augmented by grabs and 40 gallivats belonging to the Marathas. Suspicions, however, being entertained that the Marathas were acting in concert with Angria,

operations were precipitated so as to exclude them from all share in the enterprise. The Admiral having attacked and burned the pirates' fleet, Clive interposed his forces on the land side between the fort and the Maratha general who had hastened to co-operate. On February the 13th, 1756, the fort fell, and a large quantity of cannon, ammunition and specie fell into the hands of the victors. The total disappearance of Angria from the arena of external politics led to a proposal again to reduce the Marine, but this the Bombay Council declined to do, owing to the fact that war had broken out between France and England. Hence it came about that Commodore James was enabled, firstly, to seize the French ship *Indienne* and carry her as a prize into Bombay, and, secondly, to start on a voyage round the coast of India in the middle of the south-west monsoon, with the object of proving that communication between the eastern and western coasts of India was possible at all seasons of the year. This feat of navigation, which largely revolutionised the existing ideas of the value of the Marine, was of double service to the English, for Commodore James not only brought to Bengal the first tidings of the outbreak of hostilities with the French, but also lent 500 men from his ships to Fort William, by which timely accession to their strength Admiral Watson and Colonel Clive were enabled in March, 1757, to capture Chandernagore, and thus deal a severe blow to French power and commerce in the East.

Commodore James retired shortly after this and was presented with a sword of Honour by the Directors and a seat on the Board, of which he afterwards became Deputy Chairman and also entered Parliament. In 1778 he was created a Baronet and subsequently became Governor of Chelsea Hospital and an Elder brother and Deputy Chairman of Trinity House.

During the critical years of warfare between France and England the ships of the Bombay Marine were constantly engaged in co-operating with the Royal Navy, fighting actions off the Indian coasts, and in successfully acting as "the police of the Indian seas" against the many bands of pirates which still infested the Persian Gulf and western coast. Their excellent services had the effect of directing the Company's attention more closely to their circumstances and welfare; and the stringent orders from the Court of Directors anent the religious and moral character of both officers and men, and the prohibition in 1751 of gambling and swearing, were followed in 1760 by permission to wear a regular uniform, and in 1766 by the issue of a complete set of orders regarding discipline for the use of Commanders, which constituted the first body of official regulations ever published for the Marine service. Later, in 1771, the pay of seamen, who had been in the habit of demanding exorbitant wages, was formally regulated, and the total force, which had somewhat outgrown the needs of the period, was reduced and re-organised. The year 1772 witnessed the first surveying expedition undertaken by the Bombay Marine. It consisted of the schooner *Fox* (6 guns), the *Dolphin* ketch, and one patamar under the command of Lieutenant Robinson, aided by Lieutenant Porter and Midshipmen

Blair and Miscal, who engaged to explore the coast of Mekran, Sind, and Kathiawar, and a portion of Arabia and Persia. They may be said to have laid the foundations of the present Marine Survey of India, which throughout the various vicissitudes of the Indian Naval Service has ever continued to carry out the arduous task of scientifically delineating the coasts of India, Burma, and the Persian Gulf. Two years later (1774) a squadron of the Bombay marine under Commodore Watson co-operated with Brigadier-General Robert Gordon in the attack and capture of Thana from the Marathas, and in 1755 occurred an heroic struggle between the *Ranger*, commanded by Lieutenant Pruen, and an overwhelming Maratha fleet under the command of the Peshwa's Admiral Anandrao Dhulap, in which nearly every officer and seaman on board the *Ranger* was either dangerously wounded or killed.

In 1780 the ships of the Bombay Marine formed part of the squadron under Sir Edward Hughes which co-operated in the suppression of Hyder Ali; and in December two years later (1782) a squadron under Commodore Armitage, who flew his broad pennant in the *Bombay*, acted in concert with General Mathews on the Malabar coast and helped to capture Rajamandrug, Meju, Kundapur, Annanpur and Mangalore. In brief, there was hardly a naval engagement in the East during the latter half of the 18th century in which the Bombay Marine did not play a part; and it rendered excellent service at the capture of Pondicherry, Trincomalee, Jafnapatam and Colombo. Among minor engagements may be mentioned that between the *Vigilant* (6 guns) commanded by Lieutenant Hayes and four vessels belonging to the Sanganin pirates in 1797. The *Vigilant* had been despatched on a political mission to the Hakim of Soumiana, and while crossing the Gulf of Cutch was attacked by the four pirate ships, each of whom was more than double her size. After three hours desperate fighting, during which she had two of the enemy's vessels lashed on each side, the *Vigilant* managed to drive them off with complete loss. During this period of almost continuous warfare, the casualties, such as that of the *Revenge* which foundered with all hands in 1782, were largely counterbalanced by the zeal in shipbuilding of Maneckji Lavji, one of the famous family which for more than a century held the post of master ship-builders to the Marine.

The year 1780, and those immediately following it, were particularly notable for activity in ship-building, among the finest vessels launched from the Government dockyard being the *Malabar* (74 guns), and the *Ganges* (92 guns), which afrerwards served as the Flagship of Sir Edward Codrington at the battle of Navarino.

It had been found that the teak forests of Malabar produced timber which was not only more durable than oak, but also contained properties which rendered it less susceptible to the *teredo* worm so prevalent in Eastern waters. Moreover oak was becoming scarce in England, and the cost of labour in India was so low that a battleship could be built in India for £20,000 less than in England.

The first sea-going ship built by the Wadia family in the Indian Marine Dockyard in Bombay was launched in 1735. The last was the surveying ship *Investigator*, built in 1881, which was in commission for nearly thirty years. Many famous ships were built for the navy as well as the two previously mentioned, among them the *Euphrates*, *India*, *Hindostan*, and *Asia*.

In August, 1798, the Court of Directors revised the Marine Regulations, conferred relative rank as well as a retiring pension upon the officers, and formally prohibited the privilege of private trading which had up to that date been permitted to all members of the Marine service. Further, the duties of the service were distinctly defined to be —(*a*) The protection of trade; (*b*) the suppression of piracy and the performance of the general duties of war vessels; (*c*) the convoy of transports, and, if necessary, the conveyance of troops; (*d*) the prosecution of Marine Surveys in the East. A civilian Superintendent, Mr. Philip Dundas, was appointed head of the Marine Board, and the two senior officers in the service were respectively appointed Master-Attendant and Commodore at Bombay. The remainder of the personnel comprised 13 Captains, 33 First-Lieutenants and 21 Second-Lieutenants, and 37 Volunteers. Later, on the 31st May, 1814, a table of procedure in India was fixed by the warrant of the Prince Regent, whereby the Superintendent of Marine took rank after Generals and Flag-Officers, Commodores after Commodores of the Royal Navy, and Senior Captains after Captains of the Royal Navy of more than three years' service. Fresh regulations as to uniform were published in 1820, and in 1824 the rank of Commander was temporarily abolished and an increased number of Captains' appointments were created. Finally, on the 30th June, 1827, a Royal Warrant conferred upon the officers of the Indian Marine equal rank; according to their degree, with officers of the Royal Navy within the limit of the East India Company's Charter, a warrant from the Admiralty permitted the vessels of the Bombay Marine to fly the Union Jack and Pennant, and it was decided that an officer of the Royal Navy should henceforth be Superintendent or head of the Marine Service The year 1830, the last of the period under discussion, witnessed the inauguration of a family pension fund under the auspices of the Bombay Government, and the alteration of the title of the service to that of Indian Navy, the number of officers at this date being 12 Captains, 9 Commanders, 51 Lieutenants and 69 Midshipmen.

Captain Sir Charles Malcolm, C.B., was the first officer of the Royal Navy to be head of the Marine. He was also the founder of the Bombay Geographical Society, now no longer in existence, and the first important act of his administration was the commencement of the Red Sea survey.

Meanwhile the service had successfully maintained its reputation for efficiency and courage. Several vessels of the Bombay Marine participated in the Egyptian Campaign of 1801, under Sir Ralph Abercrombie, and in 1803 a squadron under Commodore John Hayes was despatched to protect the trade

of the Bay of Bengal from French aggression. It was during this year that the Company's fourteen-gun brig *Fly*, carrying despatches, was captured in the Persian Gulf by the French frigate *La Fortune*, commanded by the famous Captain Surcouff. The commander of the *Fly* with great gallantry succeeded in running his ship into shoal-water and there sinking all his treasure and despatches in order to prevent their being seized by the enemy.

In 1810 a squadron of five Bombay ships under Captain Deane helped the naval forces under Admiral Bertie to take Mauritius and capture the French ships in Port Louis. In 1811 another squadron under Commodore Hayes participated in the conquest of Java. For their services on this occasion the officers and men received the medal granted for the expedition and were warmly thanked by the Governor-General, Lord Minto. Again, in 1813, the Bombay Marine was employed in the action against the Sultan of Sambar, losing many men from wounds and sickness; and in 1815 a small squadron under Captain Blast was despatched to blockade the coast of Cutch and the strongholds of the piratical tribes of Kathiawar. During the Maratha war war the attack on the fort of Suvarandrug, in December, 1817, and the reduction of the fort of Madangad, gave further opportunities to the Bombay Marine to display its fighting capabilities, which were warmly acknowledged by the Governor-General in Council and by Colonel Kennedy, who commanded the assault on the latter stronghold. In 1819 a squadron under Captain Hall performed yeoman service in the extermination of piracy in the Persian Gulf. The year 1820 was memorable in marine annals for the siege of Mocha, which fell after a spirited defence on the 27th December, chiefly owing to the gallant conduct of the Bombay Marine forces under Lieutenants Faithful, Robinson, Jones, Elwin, and Tanner; and in the following year Captain Hardy (*Teignmouth*), Commander Start (*Prince of Wales*), Lieutenant Dominicitti (*Psyche*), and Lieutenant Robinson (*Vestal*) fought the famous action which reduced the Ben-ibn-Ali Arabs to submission. On the close of the 1st Burmese war, in 1826, the Bombay Marine shared with the Royal Navy the thanks of both Houses of Parliament for their "skill, gallant, and meritorious exertions" in the operations against Ava; while in 1827 the *Amherst* was employed under Sir Gordon Bremner in blockading Berbera and the adjacent Somali coast as a reprisal for the plunder of an English brig by Somalis in 1825.

Nor was the important work of Marine surveying neglected during these early years of the nineteenth century. A Marine Survey Department was established in Bengal in 1809, Captain Wales of the Bombay Marine being appointed the first Surveyor-General, and much important work was carried out in the Bay of Bengal by the *Assaye*, the *Panther*, and the *Antelope*. In the year previous Captain Horsburg, Hydrographer to the Company, published the first edition of his East India Directory, which was largely based upon the surveys carried out by officers of the Bombay Marine. In 1811 the *Ternate* and the *Sylph* under Captain Suree surveyed the East Coast of Africa as far

South as Zanzibar, and from 1821 onwards, under the auspices of Captain Daniel Ross, a thorough survey of the Persian Gulf and other seas was performed by Lieutenants Wellstead, McCluer, and Haines. In the schemes for retrenchment which Lord William Bentick formulated in 1828 the Marine Survey Department was almost abolished, but so important was its work acknowledged to be that in 1830 two brigs were again commissioned for survey duties. In the same year Commander John Nilson undertook an experimental voyage in the *Hugh Lindsay*, a steamer built in Bombay, with the object of proving that the Red Sea route must, with the advent of steam, become the high-road between Europe and India. The voyage to Suez took 29 days, and in spite of the difficulty of carrying sufficient coal in so small a vessel (411 tons) it was successful.

Some idea of the hardships these early surveyors underwent may be realised when we consider that in the burning heat of the Red Sea, the East Coast of Africa and the Persian Gulf they were away from civilisation for two and three years at a time in small ships of two or three hundred tons, dependent on local and nearly always brackish water, and largely living on bad biscuits and salt pork and beef in confined spaces, where it was impossible below decks for an average man to stand upright.

The Bombay Marine and Indian Navy saw a considerable amount of service in the nineteenth century. On the 16th April, 1835, Captain Sawyer, of the *Elphinstone*, shattered the power of the Beni-yas Arabs of the Persian Gulf, who had fitted out a powerful fleet of three hundred bagalas with the avowed intention of attacking and overpowering the Company's cruisers; and in the same year several officers of the Indian Navy took part in the successful expedition which explored the Shat-el-Arab and Euphrates, and paved the way for trade by peaceful negotiations with the Arabs. Three years later (1838), when it was decided to occupy Afghanistan, the vessels of the Indian Navy were employed to convey troops to the mouth of the Indus and to act as a blockading squadron at that point; while in 1839 a squadron was despatched to aid in the occupation of Karachi, which, however, fell without a struggle. In the same year, during the operation which followed the evacuation of the British Residency at Bushire, the Indian Navy ships *Tigris* and *Euphrates* were placed under the orders of Admiral Maitland, who, on relinquishing his command in the Persian Gulf, passed a high eulogy upon the conduct of both officers and men; and a still more favourable commendation was passed both by the Court of Directors in 1840 and the Bombay Government in 1839 on the conduct of Commander Haines, Lieutenant Daniel and Midshipman Nisbett at the bombardment and capture of Aden in the latter year. Nor must mention be omitted of Captain Moresby and Lieutenant Barker, both officers of the Indian Navy, who concluded the commercial treaty of 1840 with Sultan Muhammad of Seila, whereby the Mussah Islands in the Bay of Tajura were ceded to the British. The same year is memorable for the outbreak of the

China war (1840-42), when the Indian Navy ships *Auckland*, *Sesostris*, *Akbar*, *Memnon*, *Medusa* and *Ariadne* co-operated with the Royal Navy; while in 1843 the *Mootner*, the *Satellite* and the *Planet*, under Commander Nott, participated in the expedition to Sind, the officers and crews of the three ships taking part in the battle of Miani and the capture of Hyderabad, and receiving the Sind Medal with clasp for their services. Shortly afterwards, on the outbreak of the insurrection of 1844-45 in the Southern Maratha Country, the Indian Navy carried to Vengurla the troops despatched to quell the revolt; and in the military operations of 1845-46 in New Zealand the *Elphinstone* under Commander Young played a prominent part in the capture of Ruapetapekar. Well deserved, too, was the commendation passed by the Court of Directors and the Governor-General upon Commander Powell and his men who constituted the Indus Flotilla during the operations prior and subsequent to the Siege of Multan in 1848-49; and the honours awarded to officers of the Indian Navy on the close of the Second Burma war (1852) were universally held to be but a just acknowledgment of the services of men who had shared in the capture of Martaban, Rangoon, Bassein, Prome and Pegu, and had borne no small part in the suppression of dacoity on the Upper Irrawaddy. One of the salient features of the war was the excellent shooting of the Indian Navy Flotilla, which contrived, as stated by a contemporary writer, that the shell burst to a hair's breadth just where they were intended to, and did the precise amount of mischief required. The year 1852 also witnessed the suppression of pirates on the north-east coast of Borneo by the *Semiramis* and *Pluto*, while the *Queen* and the *Elphinstone* were engaged four years later (1856) in helping the Turks to defend Hodeida.

Meanwhile the condition of affairs in Persia was such as to oblige the Indian Naval authorities to strengthen their squadron and commission new warships The fall of Herat brought matters to a head, and on the 1st of November, 1855, the Governor-General issued a declaration of war against Persia. The naval portion of the forces engaged was drawn entirely from the Indian Navy, with Rear-Admiral Sir H. J. Leeke in command, and Commodore Ethersay of the Indian Navy as second-in-command. Bushire was bombarded and captured on the 10th December, 1856, and a similar fate befell the strongly fortified town of Mohammerah on the 26th March, 1857. The latter action drew from the Governor-General in Council a most eulogistic notification, of which the following is an extract:—"That the officers, seamen, artillerymen, marines and others of the squadron did their duty with intrepidity and ardour is the smallest part of the praise which is owing to them. The plan of the naval attack, which was to be carried out in shoal and narrow waters, and in a rapid current, by steamers of heavy draught, some of them encumbered with vessels in tow, and the thoroughly successful execution of every part of it, without miscarriage or confusion of any kind in face of strong defensive works at point-blank range, have given proof of a cool judgment, a well-ordered discipline.

and a skilful management, of which Commodore Young and the officers and men under his command may well be proud." Among minor services performed by the Indian Navy at this date may be mentioned the participation of the *Auckland* (Commander Draught) in the suppression of piracy in Borneo in 1856-57, and in the military operations in South China, as well as the seizure of Perim Island in 1857 by Lieutenant Templar, commanding the *Mahi*.

The outbreak of the Indian Mutiny in 1857 offered the Indian Navy further opportunity for active service. A naval brigade from the *Auckland*, *Punjab*, *Semiramis*, *Zenobia* and *Coromandel* served for nearly three years in the military operations in Bengal and Assam , the *Berenice* and *Victoria* transported troops both to Karachi and the ports of the South Konkan in the teeth of the south-west monsoon ; a second naval brigade co-operated with the military forces in the Southern Maratha country ; and Captain Jones of the Indian Navy earned the unqualified approval of both the Indian and British Governments for his energy and success in holding Persia and the Arab tribes of the Gulf at bay during the greatest crisis that British prestige in the East has ever had to face. The tale of the war services of this period closes with the successful bombardment of the Island of Bet, in the Gulf of Cutch, in 1859, and the prosecution of the China war of 1860, in the course of which the attack on the Taku forts was led by the *Coromandel*, under the command of Lieutenant Walker of the Indian Navy.

I may mention that two V.C.'s were won by the Indian Navy in the Mutiny.

As regards the organisation of the Marine and Indian Navy from 1830 to 1863, various facts deserve notice. In the first place, the appointment of Master Attendant was abolished about 1831, his place being taken by a Controller of the Dockyard ; and in 1838-39 a steam packet service for the carriage of mails to Egypt was instituted as an integral branch of the Service. In fact, from this date the Service commenced to exchange its sailing vessels for steamers ; the whole nature of the service was altered, and the establishment was reduced from 7 Captains, 12 Commanders and 45 Lieutenants to 4 Captains, 8 Commanders and 40 Lieutenants. This reduction resulted in many of the ships being under-officered, so that in 1841 the establishment had again to be increased to 6 Captains, 12 Commanders, 48 Lieutenants and 72 Midshipmen and mates. Nor was this increase final, for in 1847 orders were issued fixing the complement of officers at 8 Captains, 16 Commanders, 68 Lieutenants, 110 Midshipmen, together with 14 Pursers and 12 Captain's clerks, 14 Masters and 21 Second Masters.

At the same time the Superintendent was created a Commodore of the first class in the Indian Navy, while the Assistant Superintendent was always to be a Captain on the effective list. The post of Superintendent was, however, finally abolished in the year following (1848), Commodore Sir Robert Oliver being created Commander-in-Chief of the Indian Navy ; and the broad pennant of the Indian Navy, which had up to that date been identical with that of

the Royal Navy, was exchanged for a red flag with a yellow cross, and the Company's cognizance of a yellow lion and crown in the upper canton nearest the mast.

Despite the almost continuous war service on which the Bombay Marine and the Bombay Navy were employed in the first sixty years of the nineteenth century the important work of hydrographic surveying was not neglected. In spite of difficulties and privations surveys were carried out on the East Coast of Africa, the Gulf of Aden, the Persian Gulf, the Maldive and Laccadive Islands and on the Coast of India and Burma. In 1861 the Indian Hydrographic Office was abolished and the Survey Department worked in close co-operation with the Hydrographer of the Admiralty, by whom all charts were published, and this procedure continues to the present day.

On the abolition of the title of Indian Navy officers were given the opportunity of retiring on pension or of accepting the new conditions; the European ratings were gradually paid off and entire Indian crews substituted, these being recruited from the Mohammadan seafaring people of the Ratnagiri district south of Bombay, the descendants of the old Maratha pirates against whom the old Bombay Marine had so long struggled. These men have formed the crews of R.I.M. ships until this year, when recruiting has been opened all over India. The title of the Service now again became the Bombay Marine. Practically immediately that the Indian Navy was abolished it was generally conceded both at home and in India that the policy was a mistaken one. However, it was too late to alter it, and as is well known, Governments are not prone to acknowledge they have been in the wrong. A scheme was discussed to maintain an armed squadron in the Persian Gulf, but except that certain of the ships still carried their guns, nothing very much came of it. The ships continued to carry on naval duties in a reduced manner and in 1867 the Indian Troop Service was organised.

This was followed in 1877 by the entire reorganisation of the Marine Service, Captain (afterwards Admiral) Bythesea, V.C., C.B., C.I.E., having been appointed Consulting Naval Officer to the Government of India for this purpose in 1874. In accordance with the scheme propounded by Captain Bythesea, the Bombay Marine was amalgamated with the other Marine establishment in India under the title of Her Majesty's Indian Marine, the service being divided into a western division with its headquarters at Bombay, and an eastern division with its headquarters at Calcutta; and the duties of the amalgamated service were defined to be (*a*) the transport of troops and government stores on the Indian coasts or to any country to which it might be necessary to despatch troops; (*b*) the maintenance of station-ships in Burma, the Andaman Islands, Aden, and the Persian Gulf, for political, police, lighting and other purposes; (*c*) the maintenance of gunboats on the Irrawaddi and Euphrates, and (*d*) the building, manning, repairing and general supervision of all local government vessels and launches and of vessels and launches used for military purposes.

In 1882 the rapid extension of the Marine Service led to the abolition of the appointments of Superintendents at Bombay and Calcutta, which had formed part of the reorganisation scheme of 1877, and to the creation in their place of a Director, who was always to be an officer of the Royal Navy, with his headquarters in Bombay, and of a Deputy Director, to be an officer of the Indian Marine stationed in Calcutta. In October, 1887, the present Indian Marine Act came into force, and in 1891 Her Majesty Queen Victoria issued an order in Council altering the title of the Service to that of Her Majesty's Royal Indian Marine Service, usually called the Royal Indian Marine, and providing that the officers of the Marine should rank with, but junior to, Royal Naval Officers of equal rank, and should wear the same uniform as officers of the Royal Navy, with the exception of the device on the epaulettes, sword-hilt, badges and buttons, and of the lace on the sleeves. Previously, in 1884, the Admiralty had issued a warrant sanctioning the use by ships of the Royal Indian Marine of a special ensign (a blue flag with the Star of India in the fly) and the Marine Jack (a Union Jack with narrow blue border).

New regulations, designed to ameliorate the position of petty officers and seamen in regard to pension, were published in 1906, whereby the men were enrolled in the first instance for three years, with the option of electing for further service.

Hydrographic Surveying continued to be an important branch of the service, and in 1884 a naturalist was appointed to the *Investigator*, and since then an enormous amount of scientific research has been carried out by a succession of naturalists.

In 1871 the Indian Naval Defence Squadron was formed; this consisted of the two turret ships *Abyssinia* and *Magdala*, which were commanded and manned by the Marine, the guns being manned by the Royal Artillery.

In 1892 this squadron was increased by the addition of two torpedo gunboats and 7 torpedo boats and the Squadron was handed over to the Admiralty for the defence of India. The Squadron was commanded by a Captain of the Royal Navy as Senior Naval Officer, and was officered and manned partly from the navy and partly from the R.I.M. It was in this Squadron that the R.I.M. personnel received their war training, enhanced in the cases of officers by courses at Portsmouth and Greenwich while on furlough. The Naval Defence Squadron, which had become obsolete, was abolished in 1903.

Notwithstanding that after the abolition of the title "Indian Navy" the Marine was officially considered to be a non-combatant service, it still took its part in the struggles of the Empire.

Ships of the Bombay Marine and hired transports under the command of the Superintendent conveyed the expeditionary force from India on the outbreak of the Abyssinian war in 1868; while two of the service gunboats, the *Clyde* and the *Hugh Rose*, took part in the operations against Bahrein in 1870. The troops, guns and ammunition required for the prosecution of the Afghan

campaign of 1879 were likewise conveyed to Karachi by Indian Marine vessels, as also were the troops engaged in the Egyptian campaigns of 1882 and 1885. The year 1885 witnessed the fitting out of the R.I.M. turret-ship *Abyssinia* on a war-footing in consequence of the strained relations between the British and Russian Governments; and in October of that year the troopships and river steamers of the Indian Marine were again busily employed in the third Burmese War. This was followed by the Chin-Lushai expedition of 1889 and the Suakim expedition of 1896, in which the Indian Marine played an equally useful role; while on the outbreak of the South African War in 1899 the entire contingent from India was despatched by the Director of the Royal Indian Marine from Bombay with unequalled celerity, and a considerable number of the officers and seamen of the service were employed in transport and allied duties. The Service received the thanks of both Houses of Parliament for the celerity with which the troops from India were despatched to Natal.

The Indian Marine again saw service in North China in the Boxer rebellion in 1900-01, and in Somaliland in 1902-04, and in the gun-running operations in the Persian Gulf in 1911-12.

The outbreak of the Great War naturally found the R.I.M. unfitted to take a part as a naval service in the defence of the Empire, the officers being only partly trained for war, and the men, though loyal and well disciplined, untrained in combatant duties.

The troopships *Dufferin*, *Hardinge* and *Northbrook*, built to carry guns in war time, were immediately armed, as were also the smaller ships *Lawrence*, *Dalhousie* and *Minto*. These were handed over to the Navy and placed under a Naval Commander with R.I.M. officers and crew, the crews being strengthened with naval ratings.

All these ships were actively employed, the *Northbrook* being at one time the Flagship of the East India Squadron. The *Hardinge* took an active part in the battle of Toushoum, in the Suez Canal, where she suffered fairly heavily

The *Dalhousie* flew the Broad Pennant of the Senior Naval Officer in the Persian Gulf, and the ships were chiefly employed in the Indian Ocean, Persian Gulf and Red Sea patrols. Of the remaining officers many were transferred to the Royal Navy, serving in H.M. ships or as Naval Transport Officerrs and Officers of the Inland Water Transport, in which department many of them were transferred to the Army. The men were employed in R.I.M. ships or in the R.I.M. ships which had been transferred to the Navy and Naval Transport staffs, and with the I.W.T. in Mesopotamia.

It is interesting to note that though there were less than 200 officers in the R.I.M. there were at one time or another officers of the R.I.M. serving in the Grand Fleet, the North Sea, Atlantic, France, Mediterranean, Egypt, the Red Sea, Mesopotamia and East Africa.

The retired officers volunteered for service to a man, and those who were not too old to serve served as Naval Transport Officers and officers of the I.W.T.

in France. In fact, the organiser and head of the I.W.T. in France until his death was Brig.-General G. Holland C.B., C.I.E., D.S.O., a retired Commander of the R.I.M.

The officers of the R.I.M. gained 65 British and 6 foreign honours for service during the war, and many of the men received the India Distinguished Service and Meritorious Service Medals.

After the War the Government of India asked Admiral of the Fleet Lord Jellicoe, who was visiting India, to draw up a scheme for the reorganisation of the Service. His valuable suggestions were unfortunately too ambitious for Indian finances and could not be accepted.

Shortly afterwards the Esher Committee arrived in India to report on the Indian Army, and although the R.I.M. was not included in their terms of reference, they strongly recommended that the R.I.M. should be reorganised as a combatant service. The Government of India in 1920 obtained from the Admiralty the services of Rear-Admiral Mawby as Director, R.I.M., to draw up a scheme of reorganisation within limited lines. His scheme, however, was not adopted, and Admiral Mawby resigned his appointment.

The R.I.M. then fell upon hard times; money was scarce, the report of the Inchcape Committee necessitated drastic retrenchments, and the working of the Montagu-Chelmsford reforms resulted in the Local Governments having to defray the cost of the work of R.I.M. ships on their various stations, on lighthouse duties, transport work, carrying of officials, etc. The Local Governments were naturally inclined to think that if they had to pay they would like to have a say in the management, and that if the work could be done cheaper locally, they should arrange to carry out the duties themselves. Further, the Inchcape Committee recommended that the three large troopships should be scrapped and all trooping carried out under contract, which would have left the Marine with only the Survey Department and the Bombay Dockyard.

Happily for the Service, however, the Government of India in 1925 appointed a Departmental Committee under the Chairmanship of General Lord Rawlinson, in his capacity of Minister of Defence and Member of Council in charge of the Marine Portfolio, to submit a scheme for the reorganisation of the Service as a combatant force.

This Committee recommended that the Service should be reorganised as a purely combatant Naval Service with the title of Royal Indian Navy, with a strength in the first instance of 4 armed sloops, 2 patrol vessels, 4 mine-sweeping trawlers, 2 surveying ships and a depot ship, the Service in the first instance to be commanded by a Rear-Admiral on the active list in the Royal Navy.

The scheme was accepted by the Indian and Home Governments, and the necessary Act to permit India to maintain a Navy was passed through both Houses of Parliament.

To effect the change in the title it was necessary to draw up a new Indian Naval Discipline Act, and this had to be passed in the Legislative Assembly and Council of State in India. The Bill was introduced in February, 1928, when the Government were defeated by one vote, the defeat being caused, not by the fact that the people of India did not want an Indian Navy, but because in some cases members did not consider that the Legislature had been properly and fully consulted beforehand. Other members voted against the Bill on principle, as they considered that both Army and Navy should be directly controlled by the Legislature, while the extremists voted against it because they were prepared to vote against any Government Bill which might be introduced.

The blow to the Service was a heavy one, as it was feared that the defeat might put an end to the reorganisation. The Government, however, decided that the reorganisation should continue on the original lines, except that the title could not be altered, and that the service would have to use the old Discipline Act, a perfectly correct "Articles of War" based on the Naval Discipline Acts. To this organisation I have never heard any Indian, politician or otherwise, advance any objection, and all of my Indian friends are pleased and proud of the change, which among other things includes the admission of Indians to commissioned rank in the proportion of one to three.

In the present year, on the recommendation of the Admiralty, His Majesty the King has been pleased to approve of the change in uniform of officers to that of the Royal Navy, with the exception of the buttons of the R.I.M., which bear the Star of India as a distinctive mark, and also of the flying in R.I.M. ships of the White Pennant and the White Ensign of the Royal Navy, the greatest honour which can be conferred upon any sea service. The White Ensign was hoisted for the first time on Armistice Day, November 11th, 1928.

The Indian Marine is now reorganised as one of the fighting forces of the Empire under the command of a Rear-Admiral on the active list of the Royal Navy. Its duties are purely naval and its personnel are trained for war, and I would like here to quote from the report of a captain in the Royal Navy on board whose ship the R.I.M. ratings attached to the Shanghai Defence Force were permitted to continue their training. He wrote: "Their naturally smart and alert bearing was a distinct asset in field training and gun drill, and not the least benefit of the course was the example set by the R.I.M. ratings in keenness and zeal to all those who saw them at work. The relations between the instructors and the class were excellent from the first, and were soon supported by strong mutual respect. It is clear that the R.I.M. personnel represent most skilled fighting material."

It is probable that in the future the R.I.M. will be chiefly employed for the defence of the Indian seas, coasts and harbours, and I think that we may rest assured that the Service will worthily uphold the great traditions of its past history and maintain an honourable position among the Navies of this great Empire.

DISCUSSION.

MAJOR GENERAL SIR PERCY COX, G.C.M.G., G.C.I.E., K.S.C.I., remarked that he was delighted to be present at any gathering which brought together the members of the old Service which he knew so well. He had the very happiest memories of his association with the Indian Marine, and he could only think of them with the deepest obligation and affection. Altogether, including the War, he had been associated with the Service for thirty years. Most of those present knew the recent history of the Indian Marine and did not need him to tell it, but he would like to go back to the many inherited memories which he had from the gallant old officers of the Service whose names were still to be conjured with, and which were still to be seen on the Admiralty charts. The Indian Marine not only served on the sea, but also, in their association with the Political Service, had come to know so much about land politics that several of them had been drafted into the Political Service—for instance, Commander Felix Jones, who had been for many years Resident at Baghdad, and Lieutenant Bruce, who had been Resident at Bushire. Personally, he could remember, as Resident of Bushire, having a store-room full of very old records of the Service from the times of the East India Company, and some of those records had afforded him very delightful reading. In the days of Lieutenant Bruce, His Majesty's Minister at Teheran, who depended on Bushire for his mails and communications with India, had written to Lieutenant Bruce saying that he was expecting some guests, and that his cellar had run low and that he would be most grateful if Bruce could help him out. That was in the days when it took about a month's travel from Bushire to Teheran. Lieutenant Bruce had written back most apologetically, saying that unfortunately the occasion found his own cellar also very low, and that the best he could do was to send 130 dozen of beer. Another old record which he could remember took the form of a long correspondence which had taken place in the time when the *Hugh Lindsay* had been on duty in Bushire, and which had had to do with a feud between the officers of the *Hugh Lindsay* and the officers of the Residency for the favours of an Italian theatrical company who had been at Bushire for a few days. Perhaps, also, some of those present would remember the story of Mr. and Mrs. Bagstock, which, unfortunately, would not bear repeating at that meeting! He had been most interested in the lecture, and it had been a very great pleasure to him to be present.

ADMIRAL SIR DRURY ST. A. WAKE, K.C.I.E., C.B., said his experience of the Indian Marine had been mostly during the War when he had been in charge of the Persian Gulf from 1915 to 1918, when several ships of the Indian Marine had been attached to his Flag, the officers doing the same duty in every way as his own officers. In that connection it had been rather hard lines on the officers of the Indian Marine, and he had written home and had told the Admiralty so. They had done the same work and had to stay out a considerably longer time than his own officers, but drew only half the pay. One rule which he had had to make out there for his own officers and men was that they were sent home after two years, as otherwise they died or had to be invalided out of the Service. The Admiralty had agreed with him in that, and had relieved his men every two years. But he had had Indian Marine officers under him who had been out there for five years, or even more. That was very bad for them in many ways, both morally and physically, and he was thankful to say that the Admiralty had altered that state of things. He hoped he had been the means, by the correspondence that he had had with the Admiralty, of improving the position of those officers very considerably, who, while they had been under him, had served him very loyally and well, and whose knowledge

of the Station had been of the greatest possible help to him. He had recommended several of them for gunnery ratings in the Grand Fleet, and he believed they had succeeded in getting them. They had learned gunnery under him to a great extent, and had taken the keenest interest in it. They were just as good as his own officers, and he had been extremely sorry to say goodbye to them. If any of those present desired to get a very good knowledge of the sort of work which the Royal Indian Marine had had to contend with in the Persian Gulf he would advise them to read Sir Arnold Wilson's book on the subject, which gave a truly marvellous account of the Persian Gulf and the operations which had taken place there, not only in modern but in ancient times. Personally, he had the very greatest respect for the Royal Indian Marine.

Lieut.-Col. Sir Arnold T. Wilson, K.C.I.E., C.M.G., C.S.I., D.S.O., said he knew he could say on behalf of the members of the junior ranks in the Royal Indian Marine that they more than reciprocated the kindly feelings which Admiral Sir Drury Wake had expressed. He had heard a great deal on the subject from Sir Drury, and he was perfectly certain that if Admiral Wake's despatches to the Admiralty had been as vivid as his conversations with his friends on that and allied subjects, they must certainly have carried conviction!

Perhaps he might be pardoned for saying that he regretted the absence from the lecture of any mention of the famous names of Constable and Stife—names he had been accustomed to see on every chart as a sort of proof that it was a good chart. Nor had the lecturer quite done justice, he thought, to the extraordinary variety of work which had been done in earlier years by different members of the Indian Marine. Captain Moresby had given his name to the present Capital of New Guinea. Welstead had written a book on the archæology of Southern Arabia which had not yet been replaced, and Assistant Surgeon Carter had written a monograph on the geology of Southern Arabia which had only been replaced by a more detailed study during the last twelve months. The lecturer had mentioned natural history as being a subject which had been undertaken pretty thoroughly by the naturalists attached to the Service, some of whose monographs were very valuable indeed. He himself had compiled a bibliography of some sixty items concerning the Persian Gulf alone in the region of natural history which were owed primarily to the Royal Indian Marine Natural History Service. With regard to the War in Mesopotamia, the Royal Indian Marine had been first in the field, and for nearly eighteen months had been responsible for the Marine transport and river transport under enormous difficulties. He need not enter into a *post mortem* of the difficulties met with in Mesopotamia in those days, but he would like to point out one thing of which the lecturer might possibly be unaware. The number of Indian Marine officers who were on duty in Mesopotamia had been about 30 at the end of 1915. The new water transport had then been introduced from the War Office, and the numbers had gone up to approximately 800 officers and 10,000 or 12,000 other ranks. At the Armistice he had made enquiries as to what had happened to the original 30 officers of the Royal Indian Marine, and he found that of the 30, 20 were still holding either their original positions or more important ones, and that nearly half the posts of importance in the I.W.T. in Mesopotamia were held by the officers of the Indian Marine. That was perhaps the best possible tribute to their efficiency. In addition to all the multitudinous duties to which the lecturer had referred as falling to the Indian Marine to perform, there were lighthouse services and the management of ports. Despite the fact that there were almost infinite opportunities for being subjected to unfavourable criticism, there were few branches of the public

services in India which had been less criticised, so far as technical efficiency was concerned, than the Royal Indian Marine. He was confident from his knowledge of them, and of the general attitude towards them of the instructed public, that they were opening a fresh and even more distinguished chapter in their long history.

Mr. C. H. Bompas, C.S.I., said he was almost ashamed to take part in the discussion, as almost all he knew about the Royal Indian Marine was what he had just learned fron the lecture. He remembered reading an account of the survey of the rivers of the Sundarbans conducted by officers of the Indian Marine Service, from which it appeared that it had been almost impossible in those days to set up a theodolite without having it knocked down by a man-eating tiger. He supposed everyone had been more or less interested in the proposal, which was now taking shape, of India having a navy of its own, and one was interested to hear from the lecturer that, as a result of that, the service would be thrown open to the Indians of other races than those on the Bombay side. Most civilians' idea of the Indian sailor was the Lascar on the P. & O. and B.I. boats. They mostly came from Bengal, and he could imagine that they would show in the future that they were as good sailors and fighters as the Bombay men. Personally, he had had to administer relief funds during the War, part of which had been devoted to making grants to Lascars whose ships had been torpedoed. The deaths of Lascars on torpedoed ships had run into very large numbers, but it was true to say that there had not been a single case of a Lascar who had been saved from a torpedoed ship who had not immediately volunteered for another voyage, and he knew many whose ships had been torpedoed more than once.

Captain H. T. A. Bosanquet, R.N., remarked that it was impossible in a general survey of the history of the Indian Marine for the lecturer to mention any details of the manning of the Service, but personally he would like to recall the services rendered by the Marine Society of London during the years 1757–1861. During the whole of that time the recruiting of the European Service had been carried out by the Marine Society from the boys from their training ship, and in those years they had sent altogether to the Bombay Marine and Indian Navy 3,700 boys. The Marine Society still carried on its work at Greenhithe, but of course its connection with the Indian Navy had been severed since 1861. It seemed to him that it would be very desirable if, under the re-organisation scheme, boys from the *Warspite* at Greenhithe could in some way be sent out to India to form the European crews of the existing Indian Navy. He hoped that point might be considered.

The Chairman said it had long been a desire of his before he had gone to India that the Indian Navy should get back on to a combatant basis, and that the old Indian Navy should once more be revived. He had read Captain Low's "History of the Indian Navy," in which were described all the past exploits of the Indian Marine, to some of which Sir Edward Headlam had referred that afternoon in his interesting lecture. A good many of his (the Chairman's) ideas had been got from an old officer, now dead, who had himself been a great historian and a most enthusiastic supporter of the revival of the Indian Navy—an officer whose name he hoped the Indian Navy would never forget, namely, that of Admiral Sir Cyprian Bridge. Sir Cyprian Bridge, on every occasion that was open to him, had always done all he could to revive that old Force. Sir Cyprian had talked to him a good deal about it, and it was what he had told him, and what he had been induced by him to read, that had brought him first into touch with the subject, and that

had led him to interest himself in it. Before Lord Rawlinson had started investigating the question of the Indian Navy, he himself had gone in to the matter to a certain extent, and he had taken the opportunity at Calcutta to speak to many of the officers of the Mercantile Marine about the whole subject of the Indian as a seaman; and it had been very pleasant to hear the very high tribute which all of those officers had paid to the Lascars and to the Indian seamen who had served under them. They had said that all that such men required was good leadership, and that if they got that they would follow one anywhere. The Indian Marine and the Indian Navy in the old days had consisted, as the lecturer had said, of small ships, and the crews had been better fitted to that kind of ship than to the larger ships which had now become such horrible complicated instruments as hardly to be ships at all. The Indian Marine would have a very wide scope for its duties; it would have as wide a scope in the future as it had had in the past. There were many occasions on which there had been no British ship flying the Royal Ensign in Indian waters at all; in fact, the first appearance of a British Squadron in Indian waters had been in 1746. From 1612–1746 piracy had been kept down in the Indian waters entirely by the efforts of what was now called the Indian Marine, and also after the British Squadron had returned home the Indian Marine had once again taken on the whole of the work of the defence of the trade of India, and he had no doubt that if unfortunately another war were to come it would be found that the Indian Navy would again have those duties put upon it and would carry them out as efficiently as it had done in the past. It was a very encouraging thing, in talking to a large number of Indian gentlemen in Delhi and Calcutta, to hear them express such a cordial desire that there should be a fighting navy belonging to India. The bill for such had been turned down in a purely factious spirit. The great bulk of people, he thought, were strongly in favour of it; and although the title of the Royal Indian Marine remained at the moment he believed that it would not be many years hence when it would be called the Royal Indian Navy, and he for one looked forward very much to that day.

He asked the audience to accord a very hearty vote of thanks to Sir Edward Headlam for his very interesting lecture.

The vote of thanks having been carried unanimously, the meeting terminated.

CORRESPONDENCE.

MUSEUMS AND EDUCATION.

The paper by Sir Henry A. Miers on "Museums and Education" serves to show the increasing importance of museums to education, both to the student and to those who have passed the student age.

The change in attitude towards museums, which are no longer regarded as depositories for relics, but as living, vital organs of the community which they serve, is becoming general; and what is being done in England along these lines is being carried out throughout the whole world.

The Franklin Institute of the State of Pennsylvania, in combination with the Poor Richard Club, has recently formed a Trust known as "Benjamin Franklin Memorial Incorporated," whose purpose is to build a museum which is to be used for the promotion of science and the mechanic arts. Any of your readers, who may be interested to have complete details of this plan, I would refer to an article by Mr

Howard McClenahan, Secretary of the Institute, in the December issue of the *Franklin Institute Journal.*

What is being done in Philadelphia is being planned in many cities throughout the nation, with an interchange of material, and a resultant diffusion of knowledge. There is hope of a spread of interest to the rural sections, bringing knowledge, uplift and interest to all.

WILLIS A. NAUDAIN,
M.Frankl.Inst., F.R.S.A.

NOTES ON BOOKS.

ANIMAL DRAWING AND ANATOMY. By Edwin Noble, F.Z.S. London: B. T. Batsford, Ltd. 10s. 6d. net.

I once heard a young man ask an eminent painter how he would recommend a student to set about training hand and eye. The painter picked up the teapot over which we were talking and said: "Look at this for a minute, then go away and draw it from memory." The effort of consigning to memory as accurate impressions as possible is most important in drawing. With animals one *has* to memorise, because, except when asleep or stuffed, they do not keep still. And when stuffed they differ in certain respects from their living brethren: for instance, in the case of sheep, there is a picturesque cracking in the woolly areas in the live animal which is not found in the dead, the skin having ceased to exert its characteristic strains.

Mr. Noble's book is a sound guide to animal drawing, and agreeable to read; it is not of the learn-to-draw-in-six-lessons and get-rich-quick order. His anatomical sections are especially useful. He also traces the development of various animals from their earliest forms as known to science. It is interesting to note that Prjevalski's Horse, found in Siberia to-day, may be a living type of the original wild horse of Europe. Mr. Noble's drawings of a shire horse and a hunter, showing the different ways they carry their tails, illustrate the descent of the thoroughbred from Arabian ancestors.

The æsthetic possibilities of animals have been recognised by artists in the European traditions, but on the whole not much exploited. Prehistoric man, as at Altamira, and early historic man, as in Crete, took animal forms for the basis of remarkable designs. There are superb horses on the Parthenon Frieze—with manes of the Prjevalski type. The animal groups of Lysippos, famous in antiquity, have been lost. As Mr. Frank Brangwyn says in his preface to Mr. Noble's book: "We find animals and birds often represented in the decoration of many of the buildings of the past, in mediæval churches, and in heraldry, tapestry and all forms of painting and decoration." But neither the middle ages, which were unsentimental about animals on the whole, nor the Renaissance, which was overwhelmingly preoccupied with man, quite gave animals their æsthetic due.

One calls to mind the amusing horses and dogs of Uccello, the St. Eustace of Pisanello, the apes, for introducing which into a Marriage at Cana Veronese was reprimanded by the Venetian Signory. Later, Cuyp brings animals well into the foreground. He was a great painter; and in spite of the English love of sport and of animals—needless to say, two quite different things—our most prominent

animal painter, Landseer, was far from being up to the standard set by the Dutchman.

From the point of view of applied art, animals have provided patterns since remote Egyptian times. Mr. Noble's book will be found useful by the aspirant craftsman as well as by the student of drawing for its own sake.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 8..Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Major-General Sir Fabian Ware, "The Work of the Imperial War Graves Commission."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.30 p.m. (1) Messrs. J. Baker, T. J. Ward and H. F. E. Hulton, "The Incidence of Infection in Brewery Worts and Beers." (2) Messrs J. Baker and T. J. Ward, "Saccharomyces Sespianans."

Chemical Industry, Society of, at Burlington House, 8 p.m. (1) Mr. W. Gordon Adam, "Free Carbon Formation in Tars and Pitch." (2) Dr. D. D. Pratt, "Constituents of the Aqueous Liquors of Low Temperature Tars."

Electrical Engineers, Institution of, at Armstrong College, Newcastle-on-Tyne. 7 p.m. Annual General Meeting. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. G. H. Gardner, "Notes on the Inspection of Public Works."

Farmers' Club, at the Whitehall Rooms, Whitehall Place, S.W. 4 p.m. Mr. A. E. Magee, "The Marketing of Milk in Relation to the Incidence of Production."

Mechanical Engineers, Institution of, Storeys Gate, S.W. 7 p.m. Joint Meeting with Students' Sections of the Institution of Civil Engineers and the Institution of Electrical Engineers.

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12 Great George Street, S.W. 8 p.m. Mr. B. W. Adkin, "The Education of a Young Surveyor."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Mr. J. H. Estill, "The Port of London."

Victoria Institute, at the Central Buildings, Westminster, S.W. 4.30 p.m. Major Lewis M. Davies, "The Philosophic Basis of Modernism."

TUESDAY, APRIL 9..Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Messrs. H. S. Rowell and O. G. Williams, "Automatic Spark Advance."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. H. Hall, "The New Piccadilly Circus Station."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Annual General Meeting.

At the Engineer's Club, Manchester 7 p.m. Annual General Meeting. (1) The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages." (2) Mr. J. A. Kuyser, "Recent Developments in Turbo Generators."

At the Royal Technical College, Glasgow. 7.30 p.m. Annual General Meeting. Messrs. E. B. Wedmore, W. B. Whitney, and C. E. R. Bruce, "An Introduction to Researches on Circuit Breaking." (Electrical Research Association Report).

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Arthur Duckham, "Australia: Some Economic Problems."

Marine Engineers, Institute of, 85/88, The Minories, E. 6.30 p.m. "The Relative Merits of Pulveriser Fuel and Mechanical Stoking and their Application for Marine Purposes." Mr. W. E. Woodeson (Pulverised Fuel), and Mr. J. S. Gander (Mechanical Stoking).

North-East Coast Institution of Engineers and Shipbuilders, at the Cleveland Institute, Middlesbrough 7.30 p.m.

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Dr. L. Dudley Stamp, "The Oil and Gas Fields of Burma."

Zoological Society, Regent's Park, N.W., 5.30 p.m. Scientific Business Meeting

WEDNESDAY, APRIL 10..Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. (Meeting of Wireless Section).

Food Education Society, 29, Gordon Square, W.C. 3 p.m. Dr. Harry Campbell, "Common Errors in Diet."

Fuel, Institute of, at Burlington House, W. 5.45 p.m. Annual Corporate Meeting. Major W. Gregson, "Some Notes on Waste Heat Recovery."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5.15 p.m.

United Service Institution, Whitehall, S.W. 3.30 p.m. Commander H. M. Denny, "Destroyers in the War."

THURSDAY, APRIL 11..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. M. Lapresle "Wind Tunnel Methods of the Eiffel Laboratory."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. B. L. Goodlet, "The Testing of Porcelain Insulators."

Historical Society, 22, Russell Square, W.C. 5 p.m. Mr. J. H. Johnson, "System of Account in the Wardrobe of Edward II."

Mechanical Engineers, Institution of, at the Technical College, Cardiff 6.30 p.m. Prof. Dr. A. S. Eddington, "Engineering Principles in the Machinery of the Stars." (Thomas Hawksley Lecture).

At the Engineers' Club, Manchester 7.15 p.m. Annual Meeting. Mr. R. D. Gauld, "Factors in the Design of Steam Locomotives."

Metals, Institute of, at 83, Pall Mall, S.W. 7.30 p.m. Annual General Meeting

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Dr. F. C. Toy, "Some Optical Properties of Paints and Pigments."

FRIDAY, APRIL 12..Astronomical Society, Burlington House, W. 5 p.m.

Chemical Industry, Society of, at Milton Hall, Manchester. 7.30 p.m. Annual General Meeting. Mr. T. R. Woolaston, "Suggestions in Steam Raising."

Chemical Industry, Society of (Chemical Engineering Group), at Birmingham. Dr. C. M. Walter, "The Design and Operation of Gas Heated Furnaces."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Mr. E. J. Wayland, "The Later Geological History of the Equatorial Lakes in Uganda."

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Mechanical Engineers, Institution of, Storeys Gate, S.W. 7 p.m. Mr. F. E. F. Durham, "Pumping Plant."

North-East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne 6 p.m. Mr. W. S. Burn, "The Development and Performance of the Richardsons Westgarth Oil Engine."

Oil and Colour Chemists' Association, at Milton Hall Manchester. 7.30 p.m. Annual General Meeting.

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m.

Transport, Institute of, at the Y.M.C.A. Hall, Newcastle-on-Tyne. 7.30 p.m. Paper by Mr. J. E. Peacock.

SATURDAY, APRIL 13..United Service Institution, Whitehall, S.W. 3.30 p.m. Captain R. A. Hornell, "The Royal Navy of To-day."

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FRIDAY, APRIL 12th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

WEDNESDAY, APRIL 17th, at 8 p.m. (Ordinary Meeting.) F. E. LAMPLOUGH, M.A., late Fellow of Trinity College, Cambridge, "The Properties and Applications of 'Vita' Glass." PROFESSOR LEONARD ERSKINE HILL, M.B., F.R.S., Director of the Department of Applied Physiology, Medical Research Council, will preside.

COMPETITION OF INDUSTRIAL DESIGNS.

By kind permission of the Board of Governors of the Imperial Institute, the public exhibition of works sent in for this year's open Competition of Industrial Designs will be held in the Exhibition Pavilion of the Imperial Institute, South Kensington, S.W. Full particulars of the Scholarships and prizes offered in connexion with the Competition can be obtained from the Secretary of the Royal Society of Arts, Adelphi, W.C.2. Applications for forms of entry, labels, and instructions must be sent to the Secretary of the Society between May 1st and May 11th and the last day for receiving entries is May 27th. The designs entered for the Competition are to be forwarded to the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W., between June 10th and June 12th, and after the judging, which takes place in July, the accepted designs will be exhibited to the public at the Imperial Institute from August 3rd to September 1st (Sundays included).

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 20TH, 1929.

PROFESSOR HENRY E. ARMSTRONG, LL.D., Ph.D., F.R.S., in the Chair.

The following Paper was read:—

HISTORY OF THE DEVELOPMENT OF FAST DYEING AND DYES.

By JAMES MORTON

(Chairman, Morton Sundour Fabrics, Ltd., and Scottish Dyes Ltd.).

PART I.

Textiles are a world of their own, and it is only those who have been directly concerned with their production or distribution that can know their inner history. But even the lay-man or woman knows that within the past two decades what is practically a world-wide revolution has taken place in the standard of colour as applied to woven fabrics. As late as 1900 there was absolutely no standard of fastness for colour in textiles. These were made, and sold and bought, not expected to last in colour, for it had grown to be taken for granted that somehow things could not be otherwise. What do we find to-day ? The public have been educated to a standard totally different, and have been led to expect and demand the colours of their fabrics to be as sound as the fibres of which they are made—a tremendous revolution in this special sphere within so short a period.

Some manufacturers and distributors have questioned the commercial wisdom of raising the standard to so high a level and of offering guarantees for fastness of colour in ordinary textiles ; and as I am the original sinner, perhaps it is fitting that I should shoulder the responsibility and give the story of how it all came about. If what I have to say is largely of a personal character, or has reference mainly to our own business, I know you will excuse it, for, I gather, it is this personal experience and development that is the origin of my being invited to give a paper before this ancient and learned Society.

The story is a very simple one. Our firm had been makers of furnishing fabrics for some thirty or forty years—curtains, upholstery fabrics, carpets and such like. About 1902, after we moved a branch of our works from Ayrshire to Carlisle, I had been interesting myself in the making of certain special tapestries. We did not then do our own dyeing, but got what was the best general service of the trade from old-established dyers, and I was responsible for the colouring of these tapestries. One day in Regent Street, London, I happened to be making the usual survey of Liberty's windows, and these par-

ticular tapestries caught my eye. But they had changed so radically, that I scarcely recognised my own handiwork. Certain colours had gone so much that the balance of my schemes had been completely upset, and I went in to enquire what had happened to these goods. I was told they had only been in the window for about a week. Here, indeed, was a revelation to me. I had no idea that we were being supplied with colours that were so fugitive, and I made a resolution. What was the good, I argued, of using valuable materials and of spending time over carefully considered colour schemes, if in practice everything was to be upset by a week's exposure to ordinary sunshine, the very purpose for which the goods were made? If this could not be remedied, I felt I should want to look out for a new job

But I must first learn whether we were unique in our position, and whether there were not other fabrics on the market that behaved differently from ours on exposure. I stayed in London a few days longer, and collected from friends in the trade manufacturers' sample books of fabrics of all kinds—velvets, tapestries, damasks, dress goods, window hollands—the productions of our own country, of Germany, France, and whatever came into the London markets, so I went home with parcels of books representing many hundreds, probably thousands, of the existing colours of all classes of fabrics, chiefly cottons, mercerised cottons, linens and some silks.

Our home was then on Beacon Hill at Penrith, and our gardener had just filled a new greenhouse with young tomato plants on the side of a sunny hill. To his chagrin, next morning I told him that I was afraid I should have to upset his plans, for I wanted complete possession of that glass house. So I had those many hundreds of colours duly mounted on cards with their surfaces half covered and half exposed, and a warm, humid atmosphere maintained. Our own fabrics were exposed with the others, and I should soon see what was the state of the colour element in fabrics as they were being supplied to the trade of the day. The result was most staggering. In many cases quite deep shades, on expensive velvets, for example, became almost white in a week. Careful notes were made on every card at stated periods, but in a few weeks there was not much more to record—it was a veritable "Flodden Field," with the "Flowers o' the Forest a' wede awa'." Only a very few of that vast array held up any head at all after a few weeks' exposure. It was indeed a revelation.

As I have said, we did not then dye our own yarns, and I was to a great extent ignorant of the composition of the dyes used; but it was evident that the whole colour side of our industry was in a hopelessly demoralised condition and that dyers supplied, and manufacturers and merchants were willing to accept, anything that coloured a fibre or a fabric, regardless altogether of its behaviour afterwards. This was without any question the condition of things at the time I am now speaking of, on practically all fabrics composed of vegetable fibre, a most humiliating position for anyone who had respect

for his trade or any real interest in the goods he was making, and surely most unfair to the public, who were his ultimate customers. So I determined to attack this state of affairs—a big job enough, as you can imagine. But what was there to go upon?

As I looked at the débris of fallen colours, one here and there stood out. Certain elements in others seemed to be fairly sound. I must get to know just what types of dyes these were, and whether we could begin to build on these as a foundation.

While making this survey of colours, it so happened that I was working on a new combined weaving and printing process in which I required the use of certain coloured yarns that would stand an after-resist printing process. In this connection the representative of a certain Scottish firm brought to me some pinks, "Blush Pinks," he called them, which he affirmed would "stand anything." I doubted the statement very much, especially with the experience I was just having in my tomato house (and as a matter of fact, the blush of the pinks did prove somewhat evanescent). But the phrase "stand anything" caught my imagination, and the idea flashed across my mind—I can remember the very spot still—what if it were possible to get colours, even some colours, that would "stand anything." What a splendid triumph it would be, and what words with which to go to the trade with, against all that array of mock dyes that was obviously holding the field at the present day. So I set my face towards this goal without delay.

In the firm which this traveller represented I learned of a young colour chemist, son of the head of the concern. I sought him out, and unfolded to him the scheme I had in my mind. I took him to see my "Flodden Field," with its few survivals, and we then began a long, constructive campaign that has, I think it will be admitted, left its permanent impression on the textile trade of the world. This was in 1903.

My scheme was to arrive at a range of colours, even a small range, that could be absolutely relied upon, or as nearly absolute as practical purposes could expect, and to make from them certain types of fabrics that we should be prepared to guarantee against fading from sunlight or from ordinary washing. So we set about dyeing many hundreds of colours in every conceivable way that would tend to secure fastness. These we exposed and tested diligently, week by week, and month by month, learning as we went along. After a certain number had given promise of the necessary qualities, I made up cards of those, which I sent to a friend in India to be exposed on the roof of his house in the Punjab. I made up several sets of those cards, having alongside them corresponding shades of ordinary dyes, with instructions that they were all to be exposed uniformly, and one of the sets was to be returned to me after the expiry of each month. This gave me the behaviour of each group from one to several months' exposure under the blazing sun of India, while at the same time we were having similar tests under our own climatic conditions. From these

tests I was able by the summer of 1904 to get as many reliable colours as formed a quite respectable palette, and by the autumn of that year we had them made into tapestries that were put on the market with a guarantee that any goods fading or failing to stand ordinary laundry wash would be at once replaced. That, I believe, was the first time in the history of textiles that such a guarantee had been given, and it made a great impression in that particular department of the trade.

To give the event proper prominence, and possibly to satisfy a certain Scottish caution, I thought it advisable that those goods should be handled and announced at first by one prominent distributor only, and on my putting the matter before the directors of Messrs. Liberty in London, they at once grasped the significance and value of the idea. These guaranteed goods were first announced and sold by that firm in the autumn of 1904, and we gave them the monopoly for this country for a certain term.

It is interesting now to look back on that modest palette, and those of you who know anything of the history of dyes must wonder how we could launch on such a venture at that early date. But the Alizarines were good friends in those days, and if kept deep enough in shade, and dyed with care and real knowledge, they could be relied on for reds, deep wine colours, and such like. Then we had to recognise the value of some of the old mineral colouring matters which gave us some buffs and light browns that were very useful. But what about blues and greens? For indigo on vegetable fibre we found to be far short of the standard that would justify any sort of guarantee. Our rescue in this direction came from quite a new source. As you chemists will remember, it was just at this time that the first of the Vat colours were being put on the market—Indanthrene blue and yellow, also a grey. These proved the saviours of our scheme, and but for them we should have had to be content with a very limited and uninteresting palette indeed. But even here it was by no means plain sailing. Vat dyes were new and very sensitive and difficult to apply with any degree of levelness that would be suitable for our types of cloth. They had never been used in commercial bulk anywhere, and in our own country practically not at all, so that their manipulation was a piece of interesting new work.

To proceed with our story, this elaborately tested and selected range of colours was dyed on yarns for us by a firm or firms of dyers in Scotland under special agreement. They were woven into fabrics on our looms in Carlisle, mainly tapestries of cotton, mercerised cotton, and linen, with some special colours in wool that we could absolutely rely upon. And thus was launched this first ship of our new venture. It met with immediate response. The colours stood up to all that we had claimed for them, and in due time our first goal had been reached, for we had got to the ear of the public the fact that it was possible to obtain textiles that could really be relied upon for colour fastness.

We went our way. The orders rolled in and the machines went up till we began to be felt by the big Lancashire and Yorkshire makers. And when they realised that the road we had taken did not seem to be leading to utter destruction, they began to offer us a little of their company, so that to a small extent before 1914, and in a much greater degree during these later years, we have had many companions on the way, here, and even more largely in America, each decorated with his own peculiar badge or banner, as like the original as they could go—the word " Sun " or " Sol " or " Dour," with every variety of prefix and affix—but none of them just the plain *Sundour*. From a perusal of the trade papers one would indeed think we had become a people of sun worshippers !

We have made welcome all this company so long as they were leal and true to the standard. For what is the meaning of it all ? It means that the public apathy has been dispelled, and if manufacturers are to get their share of the trade, they must now work to a completely new standard of colour. The public has at last been taught to demand, because they know they can get, the colour element of the fabrics they use as stable and reliable as the fibres they are made of—which is indeed the goal of the crusade we set out upon those years ago.

The realisation of all this sustained a rude shock in the very height of the effort, and while we were still almost alone in the field. The threads of our web were suddenly snapped, and the gathering-up of these threads and the re-starting of the web will be the subject of the second part of my story. But before I start on that, it may be interesting for you to know something of the progress we had made up to that date and some of the satisfaction it had already brought to us.

By 1914, though we had had a progressive business in many departments of textiles for some forty or fifty years, this *Sundour* section had become by far the largest and not the least lucrative. And what about reputation ? How had the guarantee fared ? This is most interesting. At first we felt that it would be only prudent to lay aside a certain reserve out of profits against goods that were going out in such quantities with a guarantee for every yard, but after the first two years we found that this was entirely unnecessary. I do not say we had no complaints, for much may happen where so many operations are subject to the human factor. But our tests were so rigid, and our decision to use at all times only the best procurable dyes by the best known processes, regardless of cost, was so effective, that the percentage of misfits in a year was infinitesimal and therefore quite negligible. As to reputation, I could read many letters that came to us from all parts of the globe testifying to the wonderful behaviour of our fabrics. They were a great encouragement to us in those early days. To give many of them would only weary you, but as a matter of scientific interest to some of the chemists here, it may not be out of place to read one or two of these comments, just to show what properly

dyed colours on sound cloths can stand. Take this from smoky Pittsburgh, U.S.A., written from the chief store there, in October, 1910, to our New York house :—

"Feeling quite sure that you would be interested in regard to the wearing qualities of your *Sundour* fabrics we are sending to you a strip used as a window panel. Said panel has been in use for the past five years on the sixth floor window, southern exposure, and has been washed twenty times or more in our own laundry in the ordinary way. Prior to cleaning, these curtains on each occasion were black with greasy soot common to this locality, which heretofore has been the cause of taking both life and colour out of every fabric tested.

"Would like if you would carry a surplus of this *Sundour* cloth in New York as we are constantly running out of some of the colours. Will guarantee taking double our mail order if this will be any inducement to you to carry stock of our colours."

This Nigerian experience may be of special interest, written to a friend in London and forwarded to us :—

"Ten months ago a friend of mine called here on his way out to Southern Nigeria. He had been there for a number of years, coming home at intervals. On seeing *Sundour* fabrics he was inclined to pooh-pooh the idea of their being fadeless and offered to fade them for me. I gave him samples, which I have received back this morning. He had split them in two, locking one set in an air-tight case used in the jungle, and exposing the other to sun, wind and rain for seven months close to the equator. He writes now to say that he is a convinced believer, and the samples sent back speak for themselves. These I am sending to you as I thought they would interest you."

The following is a rather romantic episode of some *Sundour* curtains which we have now at the works. They were brought back by one of our directors who was visiting a friend in Yorkshire, and for the purpose of this paper I wrote this gentleman to give me the story of them. This is what he says :—

"The curtains you ask about were supplied in April, 1913, and hung at the windows of our yacht. In 1914 the yacht was given to the Admiralty, and was in constant use all through the War in various waters. When the boat was sent back, the curtains, along with the other things, were black and greasy. My wife had been rather partial to those curtains, and thought, why not try a washing of them? After thorough washing they were re-hung and looked as good as new. This was in 1918, and they have been worn constantly since on all our cruises, and would be now, had not Mr. Murray, on his visit to us this summer, 1928, begged to have them as a *Sundour* keepsake."

But one must not hurrah too soon! We never know what may be in front of us. A few months ago some cloth came back with complaint that it showed fading. We investigated and found that it had been supplied some nineteen years ago. The chief defect was that the fibres were badly chafed, but after washing, the colours were found to be so good that we kept the cloth as a splendid proof of stability, and sent the customer new material. I need not add, perhaps, that this communication came from Aberdeen!

Into quite another department of life the fame of *Sundour* colours seems to have found its way. It may be of interest to tell that in the famous Army manœuvres in Germany in 1913, the capes and caps of the Emperor, his sons, and Field Marshals, were all made of *Sundour* material dyed and woven at our works in Carlisle, and supplied by Messrs. Burberry, because they had been found to stand their most rigorous weather tests.

Just one other incident relating to Germany, which I must give at this stage, mainly because of a rather interesting sequel, which, however, does not come until much later on in my story. We were on very good business terms with the German dyemakers, and in the Vat section would be by far their largest customers in this country. We had collaborated with them a good deal with a view to getting materials that would meet our very special requirements. In the autumn of 1913 there was an important new phase that I was keen to develop. It was arranged that I should spend some time over there with our head chemist in order to go through some experiments, and we had a most interesting trip. Our time, I may say, was all spent in the application laboratories, the actual manufacturing sheds being sacrosanct. At the Badische works at Ludwigshafen we had a specially interesting time. As it was from these works that we had been drawing most of our supplies during all those years, my name and our affairs seemed to be somewhat well-known to them, and they had by them many specimens of our productions as a matter of technical interest. In showing us round their Hall of Honour, Dr. Bohn, I think it was, pointed to an empty niche in the gallery. In a jocular way he explained that that niche was being reserved for Mr. Morton, as they recognised that it was to him more than to anyone living that they were indebted for the commercial development of these Vat colours—a nice little compliment with a sequel of which, as I have said, you will hear later on.

I took the results of the experiments of our sojourn home with me. They were going through their usual tests, and for the next few months we were preparing for this new development. The holidays of July came, and then it was the August of 1914 and—the scene was changed.

PART II.

It is difficult to know just how to begin this second part of my story, for I sometimes rub my eyes even yet, and wonder whether it is not all a dream and if it is really true that one has been responsible for what is now known as Scottish Dyes, with its huge buildings and railway avenues spreading over some fifty odd acres of land, dealing with thousands of tons a year of raw products to be converted into intermediates and dyestuffs of the most complicated types, by dozens of skilled chemists, with hundreds of chemical process men, and employing something like a million sterling of good capital.

Much has been said at different times as to the condition in which manu-

facturers in this country found themselves when suddenly deprived of the supply of German dyes, but from what I have already said, you will agree that no firm, perhaps, was more hardly hit than we were. While we had our own special plant and processes of application, we had grown to be almost entirely dependent on Germany for the supply of these special products. We had developed a big and progressive world trade, and moreover, we had just formed that section of our business into a separate company for its further development—Morton Sundour Fabrics, Limited. Should we have to pull down our Fast-Dye Flag, the work of all those years? Not except under direst necessity. But just what to do? In spite of the dislocation of everything by War, trade somehow kept coming in, and stocks of dye materials were rapidly diminishing. No one among us had ever troubled to know the chemistry of these dyes - we had had enough to do with application. Very little literature was available. But as in other things at that time, this crust of ignorance must somehow be broken, and this was our plan.

In the last resort we could again revert to some of our earlier types of dyes, materials for which were all available in this country. But as in the earlier days, the crux again was the blues and the yellows, and their combination into greens. If we could get hold of just these two dyestuffs we could carry on, and our flag should not go down.

Our head dyer, though he was not a University man, and would not be considered a very profound or exact chemist, had a certain flair for things chemical, in many directions, that came in most opportunely at this juncture, and was of great value to me in those early stages. We traced out the synthesis of those two dyestuffs, and found that they were both derived from 2-amino-anthraquinone, a word that was the purest Hebrew to me at that time, but which for many days to come I had to assimilate with my morning coffee. The blue was apparently got by fusing this 2-amino with caustic potash, and the yellow by treating the same substance with antimony-pentachloride in nitrobenzene.

This mysterious 2-amino-anthraquinone was derived from anthraquinone-2-sulphonic acid sodium salt, more commonly known as "silver salt," which I learned was the basis of alizarine. Here, I felt, was a clear ray of hope. At Silvertown, on the Thames, was the British Alizarine Company, who had been large makers of alizarine for many years, and I felt, surely here were the people to tackle the manufacture of these essential dyestuffs—they were already half-way there. With this new knowledge I got into immediate touch with this company. I was in hopes that they might have already started on the problem. But this only resulted in my being told that they had done nothing in the direction of these colours; nor could I persuade them to consider doing so.

I then visited the other dye-making concerns to learn whether they were doing, or had intentions of doing anything towards the manufacture of these Vat

colours, but their reply was in the same strain. They were busy on the manufacture of general dyestuffs, so much in demand, also with essential acids for War purposes, and they could not consider taking up anything so intricate or exclusive as the Vat dyes.

I went home to " chew the cud " and to see whether, to all our new activities, it would be possible to add this further, difficult problem. For by this time we had already undertaken, among other things, the manufacture of a large number of army blankets, so urgently wanted just then. We decided that if we could procure the silver salt, we really would set out and try to do the rest of the processes ourselves. I was determined that we should have the blue and the yellow, though they should cost us their weight in gold. But it was imperative to get more definite and detailed information as to manufacture. There were no books on these recent dyes, and Patent specifications were not to be had. The only source of information was the Patents Library in London, and I was lucky in procuring there the services of a good chemical reader, who spent many hours and days extracting for us the necessary details of the various patents involved. Thus we were enabled to see something of the task before us.

I then approached again our friends at Silvertown—the British Alizarine Company—this time for a different purpose. I explained my project, and the worthy Dr. Bendix looked mildly amused. In the end, however, he let me have my silver salt, and from the smile on his face, I am sure he felt that it was like giving a schoolboy what he asked just to humour him, and that no more would be heard of it. I got the precious silver salt home, and our fun began. We had now to convert it into the 2-amino-anthraquinone which, as I told you, is the basis of our coveted yellow and blue. But what did this mean ? It involved one of the most difficult operations in chemical manufacture, and one that had never been done in this country—indeed the means for it did not exist. It involved the heating of the silver salt under a pressure of from 600 to 800lbs. per sq. inch or 35 to 40 atmospheres with ammonia at a temperature of from 180° to 200°C. By great luck we had available an old little autoclave made of Krupp steel, which had been procured years before for quite a different purpose. It held about 1½ litres, with solid cover held down by clamps, and what was best of all, had a splendid all-steel pressure gauge and safety valve.

One cannot go into all the interesting and exciting details of these first days and nights, but suffice it to say that we at last got our little autoclave to yield us quite a respectable 2-amino-anthraquinone, with its long orange needles, or crystals, and by early November, just three months after War began, we had actually produced Indanthrene Yellow G., and a few days later, Indanthrene Blue—only a few grammes of each, and I am afraid, not of the purest, but we had worked out the processes and knew something of the road we had to travel, or, shall I say, as much of it as was good for us then to know.

We had then to consider plant, and it made me smile, when looking up my notebook the other day in connection with this paper, to read the modest list of requirements that was to form the first chemical plant in this country for the making of Vat dyes—a few hundred pounds sterling in all. The chief problem, as you may imagine, was the autoclave. We decided to make it of a size to hold a charge of 8 cwts., and a steel vessel of that capacity to stand a working pressure of 40 atmospheres at about 200°C. had never been thought of in this country. However, with the help of a good local engineer, we made as careful a design as we could for an autoclave complete with stirring gear, pressure gauge, thermometer, tube pockets, safety valves, etc., and the casting was put into the hands of a London company to whom we had been specially recommended. It was a long wait for this vessel, but meantime the other plant was getting ready, and we kept getting experience with our little autoclave, making a charge every day without fail, and the cupfuls of blue and yellow colour thus got were not to be despised. At last, some time in January, 1915, the wonderful autoclave was ready, and I went south to see the hydraulic test. But it was no good. The material used had been too porous; moreover it had other faults in construction, where the makers had departed from our design, and we decided that we could never take the risk of a charge with ammonia at the temperature necessary. This was our first adverse blow.

In our extremity we heard from an engineer of a certain vessel in London that might be adapted to this high pressure and temperature, and we lost several weeks in adapting this, to find it also insufficient.

About this time I heard that one of the big dye firms had a vessel that might do such work, and I went at once to see if they could extend us temporary accommodation. I mention the incident because of its effect in other ways. The gentleman whom I saw seemed astonished at my visit and my request. What were we up to? This was a chemical operation, and we were only weavers, or some such remarks rather in disparagement of people like ourselves trying to make dyes, especially dyes requiring such processes. From my after-knowledge I learned that he had really no plant that could have helped us, so that his methods may have been by way of a screen, or bluff. But it had the effect of putting further fight into me, and "Begad," I said to my friend who was waiting outside, "I will let that man see yet whether weavers can make dyes." The next time we met was some four years later, after much water had flowed under the bridges. We had been asked to speak on the same platform at an important chemical meeting in London, and no one could have been more complimentary to our accomplishments than this man on that occasion.

But what about our autoclaving? The above incident was in early March. It was impossible to wait further months, for we were starving for colour. So we thought, why not try weldless steel tubing, and we learned that a length might be available at Cochran's boiler works at Annan. I can remember the very cold night on which we drove out to Annan on that quest, the

keenness and determination of each of us, and we brought back in our car the tubing, which event occurs in my notes, under date just three weeks after the rebuff recorded above, as follows :—

"Saturday, March 27th, 1915—Have had first satisfactory results silver salt into 2-amino-anthraquinone from improvised autoclave made out of Stewart and Lloyd M.S. Tubing 3ft 8in. long by 10in. diameter. Charge 7 gallons silver salt and ammonia, gave us sufficient ammo for 20 lbs. of colour. Immediately put two other vessels in hand, which should give us 60 lbs. per day, sufficient to dye 25 to 30 pieces cloth of a medium blue or green."

It was one of the red letter days, and though the colour was by no means "standard," it was the first real works Blue and Yellow Vats produced in this country, made, as you see, at the works in Carlisle, and from plant practically all local. It was, as I have said, the real beginning for from that day we have never ceased getting our supplies from our own production. And it will give some idea of the growth from that small beginning when I tell you that of these two colours, or their variations, our plant has now a capacity of over 10 tons a week, or about 1 million lbs a year.

By October of that year 1915 a thoroughly sound 8 cwt. autoclave, with stirring gear and everything complete, had come to the assistance of our little battery of tubing autoclaves. This was cast by Edgar Allen of Sheffield, and proved sound in every way. It was succeeded by one of a ton capacity, also made by the same firm, and later by some from Hadfield of Sheffield, and others, most of which are still running.

I have given you the history of these autoclaves in some detail because they are one of the chief keys in the manufacture of Vat dyes, and because they represented a problem in high pressure and high temperature reactions that was quite new to the chemical and engineering experience of this country, and that demanded a combined skill and knowledge of the highest order.

Fresh obstacles however had in the meantime been developing to an easy road to our dyes production. As I have told you, we began by getting our silver salt ready made, but it was soon apparent that this source would be no longer available. This meant that we had to tackle the whole problem of the manufacture of these long-process dyestuffs, not only from the silver salt forward to the finished dyestuffs, but from the crude coal-tar anthracene right through its stages to the silver salt. The chemists among you will realise something of what was involved. Commercial anthracene could be had of 40% purity only. This had to be purified up to 95% at two stages. It had then to be further sub-divided by sublimation with super-heated steam, which again had to be converted into crude anthraquinone and this developed up to a purity of 95% before it could be ultimately sulphonated with oleum into the desired silver salt.

Such was, roughly, the further road we had to travel for lack of a supply of ready-made silver salt. It was a road with obstacles enough to scare

amateurs in ordinary times, and when one thinks of the conditions then existing, one wonders how we ever started or ever got through. For it was just then that the nation was realising how long and tough the struggle of War might be. Every man and every human activity were claimed for the services of the War. And not only men, but materials. Can one forget the difficulty with which we could be spared a few pounds of lead or a few hundredweights of steel, or how we felt it almost criminal to beg, for any purely business purpose, the smallest extra supply of sulphuric acid, oleum or glycerine? I recall these facts now, not only to give you younger people some idea of the tense conditions of those times, but since criticism has sometimes been lodged against British dye-makers because they were not more advanced in their problems and production by 1918. Such criticism is apt to forget that not only were we all in person mainly engaged on other work essential to the War, but the very elements that go to the making of dyes were scarcely procurable.

By dint of many and varied efforts we got our new buildings and plant erected, on a small scale at first, and later in much bigger form, so that we were ultimately equipped for the making of these anthraquinone colours from the coal-tar to the intermediates and the finished dyestuff. Having had to extend our operations to this broader field, we naturally made investigations as to what other colours we should tackle to justify this comparatively large chemical plant. Our chemical reader at the Patents Library had been kept very busy, and had supplied us with the necessary data for our own group of Vat dyestuffs, and in the meantime we had gathered round us several young men of chemical training, so that research was now going ahead in our own laboratories.

Much of our attention just then was concentrated on colouring matters dependent on the initial production of benzanthrone and the working of this up to a high state of purity was one of the problems that engaged much of the attention of our chemists over a long period. The highly successful results of this work were of far-reaching importance in the later stages of our development, as pure benzanthrone became a very essential factor in the manufacture of new colours, to which I shall refer later.

Apart from these Vat colours for our cotton trade, one of the dyestuffs that lay nearest to our path, and one that we knew would be of great use to the trade of the country was what had been known as "Alizarine Sapphirole," one of the sulphonated-amino-anthraquinones, containing Hydroxyl groups. This came in for early investigation, and by March, 1916, we had produced it in small quantities, while by the summer of that year we were making it for use in our own carpet dyehouse, and had sold little lots quietly to our carpet friends, who prized it mightily. It is the fastest of the acid wool colours, and was looked upon as the key colour in blues for wool. Indeed, if it had been permitted to import one dyestuff during the War, and if there had been a census among wool dyers, the vote would have gone overwhelmingly in favour

of Alizarine Sapphirole. To give you some idea of the value of this colour, and the great loss felt by its absence, I think it worth while giving you a statement from important persons in the trade, which will speak for itself. On November 23rd, 1916, Mr. Sutcliffe Smith, a director of the Bradford Dyers Association, and for some years now chairman of the Colour Users Association, wrote an urgent letter to Mr., afterwards Sir Milton Sharp, chairman of that company, urging him to do all in his power to stimulate the production of Alizarine Sapphirole by some firm in this country, and in order to show its extreme importance, he proceeds :

> " During the first six months of this year we dyed for this trade 55,872 pieces. The average value of these pieces amounts to £14 per piece, making a cash turnover value of £792,208 for the six months.
>
> " On account of our inability to obtain Sapphirole, our output has been so seriously curtailed that, had we been able to secure this dyeware, we could, with the same men working the same number of hours, have turned out 83,808 pieces as against 55,872, and the value of goods passing through our hands would have been increased to £1,173,312, or to sum up, goods to the extent of a further £762,208 would have been treated in a year. No effort should be spared to produce this dyestuff as I cannot over-estimate its importance to the whole of the textile trade, and its production will not only re-habilitate British reputation, but will be a distinct step in advance and a serious attempt to strike at Germany's supremacy."

So much for the importance and value of this dyestuff to one firm, and that was typical of the whole woollen and carpet trade over the country. This letter was written on November 23rd, 1916, and was quite unknown to me at the time. We had been making the colour, using it ourselves, and supplying it to a few friends in the trade, as you have been told, for six months previously.

But as I must explain at this point, we had given no publicity of any kind to our dye-making activities. We were using our production mostly for our own trade, and so had no occasion to advertise these activities or whatever achievements we might be said to have accomplished. On November 28th of that year, 1916, there appeared a very triumphant advertisement in the morning papers from a large Dye Company under the heading " A New British Dyestuff —Indanthrene Blue," claiming that whereas German chemists had prophesied that no British firm would produce this Vat dyestuff within ten years, they had now accomplished that feat. In spite of my native modesty, I thought it only fair to our chemists and to the situation generally to let it be known that this feat of the big Dye Company did not represent the high watermark of British achievement—that we had been making that colour and others of the same series for over eighteen months, and that many thousand yards dyed by these colours had already gone from our works to all parts of the world.

This letter of mine to the public press had the effect of bringing many enquiries from users, and among them one from the Bradford Dyers Association, who had learned that, besides Vat Colours, we were actually producing Alizarine

Sapphirole after which, as I have shown, they were so much hungering. It led to an immediate meeting between the directors of that company and myself and much useful collaboration afterwards. They had delivery of the Sapphirole —which we called " Solway Blue "—within a few weeks of our meeting, as well as of some of the Vat colours, and they have not ceased to get them in increasing quantities and varieties from that day to this. I want here, if I may, to put on record the great spur given to our efforts by the directors of that company, especially by their late chairman, Sir Milton Sharp, who both in private and public was so frankly generous in his appreciation of our endeavours. It was a great help and stimulus at a difficult time. And these things are not forgotten.

As I have said, that little bit of almost compulsory publicity brought us enquiries for colours from users all over the country, and we had to multiply the production as quickly as the conditions would allow. Of that most indispensible blue colour we were making by 1918 half the total pre-war imports, and by 1919, 50% more than the total pre-war imports; while to-day our production is several times the total pre-war imports, and the colour is also made now by other firms in this country.

This was, perhaps, one of the chief services we rendered to the general trade of the country in the War, and I believe users were agreeably astonished at the moderation of our price. I sometimes think now that had they been dealing with a Scotsman from Aberdeen instead of one from Ayrshire, they might have been asked to pay a somewhat different figure for a commodity so invaluable at the time—one of those little facts of which one likes to remind the users in our controversies to-day!

With these outside orders rushing in—we had one contract for 100 tons of colour—our dye-making section was becoming a place of considerable activity, and it was at this time that we decided to detach it from our textile business. It was first run under the name of " Solway Dyes Company," still owned and operated entirely by ourselves. I was averse then to inviting outside capital for a business that had so many risks, and even now might only be temporary.

But, as you can realise, all that long research by chemists, and the erection of buildings and plant to cope with large production, had made us dip fairly deeply into our coffers, and we were a comparatively small private concern. This possibility occurred to me. Why should we not try to interest some American makers in the results of our hard earned experience? The money would be very useful. Several firms over there had been making dyes, but none so far had attempted such a colour as Alizarine Sapphirole, and very little had been done on Vat dyes. These anthraquinone colours were bound to have a large demand in the American market. We set out to interest some one in the making of them with a view to helping our finance in this obvious and natural way. It was still War-time, and negotiations were difficult, but during

1918 a plant was erected in America for the manufacture of a ton a week of our Solway Blue (Alizarine Sapphirole), from plans and processes prepared by us, and two of our chemists from little Carlisle went out to set that plant agoing in America. And it is working regularly till this day.

In the next year, 1919, I went to America with a view to extending this idea. It led to an arrangement between ourselves and a large chemical company in America that has been of extreme importance and mutual value. In works over there were put up duplicates of what we were doing here. That arrangement has continued unbroken, and to-day they are supplying dyers and manufacturers of America with a large proportion of their very extensive requirements of Vat colours. There is a complete interchange of information and experience. This has brought advantages to both, and the association has been one of ever-increasing co-operation and cordiality.

But my visit to America, which lasted some three months, had another result which turned out to be of far-reaching importance to our enterprise, and which I must relate as briefly as I can. By the end of 1919, it was evident that our dyes venture was to be no passing phase and we had already taken an important step towards its establishment on a permanent basis. This step, I should like to record, was taken shortly after, and as a direct result of a speech by the President of the Board of Trade, Sir Albert Stanley, now Lord Ashfield. In this speech he had explained the Government policy, whereby there would be a certain regulation in the importation of dyestuffs for ten years after the War. Certain grants-in-aid would be given towards research, and also towards construction of plant for colours not yet made in sufficient quantities in this country.

Up to this date all our dyes activities had been carried on in buildings adapted or erected within our textile area, and these were proving quite inadequate to cope with the demands now being made upon us. We decided that future developments should be on fresh fields—near the sea for effluent, and where we could have ample supply of suitable water and good transport facilities. Ultimately Grangemouth was chosen as fulfilling these conditions. There we got a site with an option on eighty acres, and we then became Scottish Dyes Limited. At this juncture we invited the financial co-operation of one outside party, a gentleman already interested in chemicals and thoroughly conversant with all the risks that might attach to a new dye industry in this country. At a later stage a few of the larger colour users and suppliers of chemicals also became financially interested in our undertaking. The construction of this new place was going ahead while I was in America at the end of 1919 and the beginning of 1920. We were laying plans for the manufacture of anthra-quinone dyestuffs on a big scale.

But one factor had often worried us, and now became more acute in view of these extensions, namely, the supply of anthracene, which was the basis of all our operations. This hydro-carbon forms a very small fraction of the

coal-tar, and very few distillers would trouble to extract it, with that any industry dependent on anthracene was at the mercy of a Even in our short experience we had had difficulties about supplie several occasions we had had to pay exorbitant prices. It was obvious that if another source could be found for our necessary raw material, we should be on a much sounder footing for large operations.

It came to our knowledge that a new process had recently been discovered in America for the production of Phthalic Anhydride from naphthalene by an air oxidation process. We had been aware that the production of anthraquinone from Phthalic Anhydride was an alternative source of supply for our starting material, but the cost of Phthalic Anhydride by any previous process had seemed to shut the door to this avenue. It struck us, however, that by this new air process the cost must be so low that it might bring the process within the field of possibility. So it was one of my other missions on this visit to America to investigate this process, and to see whether the conditions were such that it might solve for us this outstanding trouble of anthracene supply. For it was obvious that if we could switch over from anthracene as our basic material to naphthalene, we should be on absolutely safe ground. Not only is naphthalene much lower in price, but the supply is practically unlimited, representing as it does a fraction in the coal-tar some 15 to 20 times the volume of anthracene. And it is isolated by practically every tar distiller. It was worth any effort to enable us to realise a condition of this kind. But would it be possible for us to acquire the process?

I must really refrain from entering on the story of that deal in America for the British rights of this new process for the manufacture of phthalic anhydride. If I ever write a romance, I think I shall call it by that sweet name! Suffice it to say that when I recrossed the Atlantic, it was with this "ugly duckling" as part of my baggage. For when I presented it to our boys in the home yard and told them the cost, their congratulations, or their words of welcome were, I am afraid, not too effusive!

Other things were happening in the dye trade just then that made the advent of expensive "ugly ducklings" not too auspicious. I mentioned a short time ago that we had launched on our bigger scheme of dye-making on the basis of the Government promise to restrict the import of dyes for ten years. This declaration of prohibition was given under an Act of 1876, whereby the King had power to prohibit the importation of arms, ammunition, gunpowder, or any other goods. The Government relied on the words "any other goods" to enable them to exclude chemicals and dyestuffs. In August, 1919, this restriction was contested by a firm who wished to import certain chemicals, and the court, by what was called the Sankey judgment, held that the words "any other goods" in that connection did not refer to chemicals or dyes, and that the Government had no power to prohibit the importation of these materials. As a result, there followed a full year in which users were free to import all the

dyestuffs they wanted. At the same time the Government saw fit to take as part of their reparation payments from Germany huge quantities of dyestuffs. So that during the year 1920 and into 1921 it is claimed that dyestuffs to the value of something like £7,000,000 were arranged for import to this country. At the same time the Indian market, which had formerly been considered closed to German dyes, was made free to that country, with the result that large contracts which had been given to dye-makers in this country, ourselves included, were immediately repudiated. On the heels of this came what was known as the slump in trade, when demands for goods of all kinds seemed to stop in a single night. That combination of events made very melancholy times for the dye-makers here who had erected or were just erecting plants to supply the total needs of the country and the Empire. It was a cold draught indeed, two years of a bitterer wind than one ever wants to know again.

But this hiatus, like adversity, was not without its uses. If our chemists were not needed for production, they could research ; they could improve and revise many existing processes, and they could venture out on new fields. So in these two adverse years, though we drew in our horns in many ways, we did not dispense with the services of a single chemist. Indeed, it was a time of precious research, which bore much good fruit, as you will see.

Among other things, it gave time for our chemists to make better acquaintance with the ways of the little " ugly duckling " which I had thrown among them so unexpectedly. Like others, it had passed through a hazardous time enough. It seemed to contract certain foreign troubles as well as some home maladies, but at length it developed some quite unexpected feathers, and was soon to become the pet bird of the flock. Our chemists discovered that these beautiful long white crystals of phthalic anhydride were capable of flights which they had never anticipated. We had certainly expected them to bring us anthraquinone from naphthalene that would make us at least independent of the more limited anthracene, and perhaps at a lower price. This was soon accomplished, but our chemists found that not only could they get an anthraquinone of the requisite purity much more easily, but that it offered a ready avenue to new and important derivatives of anthraquinone without the necessity of passing through the anthraquinone stage—the white wings of the phthalic made possible the flight, free of that island altogether.

As you chemists may know, a simple transformation involving phthalic anhydride consists of the production of benzoyl-benzoic acid from it by condensation with benzene. Benzoyl-benzoic acid is simply anthraquinone with an extra molecule of water added to it, thereby leaving one of the links open between the two outside rings of the molecule. When this ring is closed by extracting the water with an agent such as sulphuric acid, anthraquinone is formed. But in most of our operations for which anthraquinone is needed it is not necessary to isolate the anthraquinone. The benzoyl-benzoic

acid acts as a raw material, and can be directly converted into any intermediate for which anthraquinone was formerly used. The application of this discovery by our chemists as a new use of phthalic anhydride is of far-reaching importance in the realm of anthraquinone dye-making, and is the subject of several Scottish Dyes patents. It now permeates practically all branches of our many processes, and has enabled these anthraquinone derivatives to be made with a degree of purity and at a price that was unattainable from the old process from anthracene. Indeed it may be looked upon as a revolution in that section of dye-making.

One outstanding result of this process, and one that could never have been attained otherwise, is that it has enabled Scottish Dyes to make and put on the market a Vat Blue colouring matter which is without question the fastest blue on the market. What is more, it is the fastest blue that has been made anywhere at any time, ancient or modern—a very big claim to make! It has only been on the market some three years, and it will give you some idea of its recognition by the users of dyes if I tell you that of this one blue we now make more tons a year than the total imports of all Vat colours put together before the War. That I look upon as one of the greatest achievements of Dr. Thomas and his staff of research chemists, done largely during the slackness created by the "dump" and "slump" period—but, as I modestly remind them, something they could never have done but for the advent of my not-too-welcome "ugly duckling," the phthalic anhydride.

Our "duckling" is only at the beginning of its hatching. The latest product from it is Alizarine Red (Turkey Red) by a new process from para-chlor-benzoyl-benzoic acid, a derivative of phthalic anhydride. This red is the purest of its type that has yet been made, and a plant for its production of about 20 tons a week is now in operation. Another product about to be marketed is benzoic acid of a very high purity. Phthalic anhydride is also beginning to be used in this country for the manufacture of condensation resins for electrical work, and its uses in other directions keep ever on the increase. We are now making many tons a week of this beautiful crystal phthalic anhydride for our own use and for general sale, and the plant is about to be doubled.

I must now refer to another product whose growth was specially nurtured during that adverse year till it ripened and fell into our harvest basket to brighten an otherwise gloomy autumn. I refer to Caledon Jade Green, a product by which Scottish Dyes has become better known perhaps than by anything else we have done. But that was not the result of a day or a year. As users before the War, we always felt much the want of a green of pure quality for our *Sundour* goods. Early in the days of our dye-making, and as soon as we had research chemists of our own, I determined that we should have a hunt for such a green. It was one of the obvious blanks of the Vat palette, for we had pure blue, yellow, purple and red, and I somehow felt that somewhere

amid that maze of compounds a green, such as was wanted, was lying buried. It was a vast field that had to be explored, and we knew it must be a long and tedious road. For over four years one or more of our chief chemists and assistants were engaged mainly on this quest. Long periods there were of blank sterility, but ever and again little crops of verdure would give indications of something coming, only to be left behind again and the hunt restarted. At last, on the 11th September, 1920, the chemists came triumphantly to me with the first few grammes of the beautiful green colour that has not changed since, and that has indeed made history for itself and for Scottish Dyes. It was somewhat bluer in tone than one had hoped for, but a beautiful Jade, and it was there and then christened, and has ever since been known as "Caledon Jade Green"

The provisional specification was filed on 27th November, 1920; the complete patent was granted on 29th May, 1922, the British number being 181,304, and the Jade Green Patents over the world number 22 in all. Briefly, it is produced by oxidising dibenzanthrone to the hydroxy-derivative by means of manganese dioxide and sulphuric acid. This is then methylated with dimethyl sulphate to give the Caledon Jade Green. Plant for its manufacture was immediately erected both here and in America, and in a short time it had made a place for itself second to none in the Vat range. But why was it so important a colour that it should make such an immediate impression in the dye trade? Because not only was it the only pure green of the anthraquinone Vats, but it was found to be the fastest all-round colour of the whole Vat series.

We learned, shortly after it was on the market, that the German dye-makers had adopted it in their laboratories as their new standard for all-round fastness —a tremendous honour to a new and foreign-made colour. Perhaps no achievement up to that time had so convinced the Germans that British dye-makers were now a factor to be reckoned with.

But this colour was patented in Germany, and they could not produce it. What would happen we sometimes wondered; for we knew that they could not ignore the advent of a colour so outstanding as that Jade Green. In due time diplomatic soundings came, and in their wake developments which may almost be called historic. For these negotiations led to our being visited in the North by three of the chiefs of the Badische Company of Ludwigshafen to discuss terms for the production by them in Germany of our Caledon Jade Green.

That was on the 3rd July, 1925. I am frank in saying that we took the visit as a great compliment. It was the first time that I know of in at least half a century that representatives of a German company had come to Britain on such an errand. They were not easy negotiators, but we had a most friendly meeting, and at last the conditions were adjusted to the satisfaction of all parties. And now comes the sequel to the incident which I gave you

in the first part of my story. You must remember that these three gentlemen were from the same company as I had visited in the autumn of 1913. When everything had been properly adjusted and documents signed, and we were indulging in more easy talk, I recalled to my friends in a bantering way the occurrence I have already mentioned to you, and Dr. Bohn's jocular suggestion of placing my bust in the vacant niche in their Hall of Honour. "What about that bust now?" I chaffed them. "Surely the Jade Green deserves the honour." Their spokesman looked at me somewhat seriously. "Bust!" said he, "do you know, Mr. Morton, when we read your specification for that Jade Green we were so wild at having failed to discover it ourselves that we could have 'kilt' you." They were most complimentary all the same, and in order to be quite fair on our side, I want to relate here that the collaboration with that company over this colour led to a suggestion on their part for an improvement in one of the stages of manufacture that has enabled us to produce it at considerably less cost, and has given the colour a much wider field of usefulness. In this both parties have benefited. As to the importance of the colour, I think it will not be questioned if I make the statement that it is the most outstanding discovery in the dye trade since the introduction of the first Vat dye-stuffs a quarter of a century ago. For this Jade Green is the fastest green made anywhere to-day. It is perhaps the fastest colour made anywhere. It has been on the market only a few years, and though I have not quite full data to verify it, I am going to venture the statement that of this Jade Green there is a bigger tonnage being made in the present year, between here, America and Germany, than the total tonnage of all the Vat colours put together in the year before the War. And the research and discovery of that epoch-making colour was all done in the little laboratories at Carlisle.

I feel that you must have had more than enough of the details of a dye works. Before closing the catalogue, however, I just want to refer to one other phase because I know it is one that is sure to loom large in the future. For the most part my remarks have made reference to Vat colours, and in one's mind one always considers them in their relation or application to cotton or vegetable fibres only. This is owing to the fact that, except in a few cases, the amount of caustic soda necessary for the dyeing of these Vats makes them inapplicable to wool or natural silk, as the caustic destroys or tenders the fibres to a very great extent.

It has always been a dream of the manufacturer to get the use of these fast colours for wool and natural silk, and the trade has been waiting in expectancy for its realisation ever since the introduction of the Vat colours. In our textile laboratories we have spent much labour and research over this problem for several years. It was obvious that if these Vat dyestuffs could be got soluble in water, and could thereby be applied direct to the fibre without vatting in an alkaline bath, the desired end would be attained. This is a research which I caused to be instituted in our textile dye

laboratories some years ago. In August, 1924, we were at last successful in finding a suitable process for rendering these anthraquinone Vat dyestuffs soluble in water. This process was at once handed over to Scottish Dyes to develop on a manufacturing basis. In January, 1925, we issued from our works at Grangemouth Caledon Jade Green in a soluble form as the first of what we called the "Soledon Dyestuffs." This was the first anthraquinone Vat dyestuff to be put on the market by any firm in a soluble form. A few months previously a Swiss firm had put indigo on the market in a soluble form under the name of Indigosol, but it was by a different process of manufacture. They have confined their commercial activities so far, with perhaps one exception, to the production of soluble Indigoids or closely related compounds.

This process of converting vat dyestuffs into their soluble sulphuric acid ester derivatives is a development that is now going on at Scottish Dyes in a vigorous way, and that has very great potentialities. It is a problem, so far as anthra-quinone Vats are concerned, that has been lying to be solved for many years. I am sure that in times to come it will be one of the main claims to distinction attaching to the chemists of this country in this age—that the long-looked-for solution has come from the chemists of these two British concerns—Morton Sundour Fabrics and Scottish Dyes. It is difficult to prophecy, but I do not think I shall be far from the mark if I hazard the statement that in ten years' time all the so-called Fast Vat colours will be used mainly in this soluble form on cotton and other vegetable fibres as well as on wool and natural silk. I shall be much surprised also if they are not all, or nearly all, made by the new and simple process developed and fully patented in all countries by our two companies.

I want to record here the splendid support given to all this work from its very inception by the chemists and engineers of the concern. They began as a very small band indeed, but they were loyal to the venture, and those who were there at the first, some fourteen years ago, are there to-day. We have not had cause to dispense with the services of a single chemist through all those years, nor has one left us, though several tempting offers have come their way. It may be interesting to relate that we have not at any time engaged, nor have we now in our employ, a single chemist who had previous experience in dye-making. They have been a band of ever-increasing strength, working in the friendliest co-operation and loyalty under Dr. Thomas, their head. We have had to mourn the loss through death of two young chemists, one of them, A. H. Davies, a scientist of great ability and promise. We have been lucky during most of these years in the official co-operation of Sir William Pope, of Cambridge University, whom we look upon as the father of our team, while for an even longer period we have had the countenance and constant interest and encouragement of Professor Armstrong, our chairman to-night, whom we may call the grandfather of the family. His visits, of a purely friendly

interest, in the early days were a source of great help and inspiration, which I should wish to put on record.

In these more recent days we have all been adopted and have become part of a much larger family, for we were considered worthy of being included in the group which now forms the great Imperial Chemical Industries. While we continue our own activities and carry on along the old lines, we bask in the beneficence of the big chemical sun, and I see no reason why under it we should not produce fruits more precious and plentiful than ever in the past. For research is made more possible, and, what is most important, the fruits of research are capable of immediate realisation by reason of that great Bank on the River Thames

In closing the first part of my story I told you how the threads of our web had suddenly been snapped, and how the second part would tell of the gathering up of those broken ends, their piecing together and the starting of our new web. The work involved in all this process has kept us so busy and so absorbed that one has scarcely had time to look at this new web, now that it is in full swing again. Had it not been for the kindly insistence of friends, I question if one would ever have taken the leisure to sit down and look at it all in the way that the preparation of this paper has entailed. When one compares the new with the old, I am sure you will agree that we have now a web whose threads have in them a strength and an interest incomparably greater than anything they ever had before. Every colour we use now speaks and lives and is full of the intensest new meaning. For instead of colour being only a blank page to us, it is now filled with a story of supreme interest, of long, arduous research, of high pressures and high temperatures, things attempted and done, telling also of things yet to do that are full of hope and adventure, which, after all, is real life.

I only hope that in what I have said I may not have given the feeling of too much self-satisfaction in our accomplishments. There has been in certain quarters some adverse criticism of the slow progress being made by dye-makers in this country, especially, as it happens, in relation to Vat dyes; and some of the statements I have made I have thought perhaps overdue in reply to such criticism. But I can assure you that we are only too aware of the minor part we play in the great field of chemistry and even of dye-making. What we have learned and what we have done have only taught us how marvellous are the wonders of the new world to which we have been introduced, and of which we have touched only the margin. And among the things it has enabled us to appreciate the more is the gigantic work represented by the growth of synthetic dye-making in Germany in the past fifty years. Only ignorance would try to belittle what has been accomplished by the chemists of that country during these past decades. If you young chemists want to be enthused and to get inspiration for your work, read the story of the inception and development of synthetic indigo as told by Dr. Brunck in his historic speech

at the opening of Hoffman House, in Berlin, in 1900. It tells a story of initiative, skill, and indomitable perseverance against obstacles, for a period of eighteen years, that are worthy of a great epic. No one must ever deny them the honour due to that great work and others like it. But we must never forget, and the Germans always graciously acknowledge it, that they got the scent of all this trail from the young man Perkin of this country, who kept it valiantly for many years. We lost that trail some fifty years ago, but in the upheavals of these recent times our senses have again been quickened, and we have, I hope, caught up that trail again. This is all I should want to claim from the recounting of such incidents as I have given you and they could be multiplied from other works. We are again in the field, and it is for you young ones to keep keen of scent. See that you prove good sportsmen and that the trail be never again lost.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said there was no one, probably, to whom Mr. Morton's lecture could have the significance that it had to himself. The man from whom all these blessings flow, Hofmann, had been his first master in chemistry. It was Hofmann who, in 1843, had made the discovery that the reduction product of the nitrobenzene prepared from Faraday's benzene (1825) by Mitscherlich in 1834, made by Zinin in 1841, was to be identified with Fritsche's aniline, also first obtained in 1841, by distilling Indigo (Portuguese anil) with potash. Hofmann had exploited aniline with a marvellous enthusiasm, skill and thoroughness. He (the Chairman) had told the story at length in his contribution to the Hofmann Memorial Lecture before the Chemical Society. Hofmann, it should be noted, had set Perkin to work on anthracene.

In 1869 he (the Chairman) had worked in the Leipzig laboratory alongside Graebe, then a Privat-docent. In collaboration with Liebermann, Graebe had then but recently established the relationship of alizarin with anthraquinone. He recollected Graebe coming to England to negotiate with Perkin over the Alizarin patent. On his return to England in 1870, Perkin had been one of the chemists with whom he was at once intimate and he had had the privilege of becoming his colleague, as junior Secretary of the Chemical Society, in 1875. Perkin had laid the foundation stone of the dye-stuft industry by his discovery in 1856 of Mauve, which he began to manufacture at Greenford Green in 1857. He (the Chairman) had known all the chief actors in the great colour drama ; a more brilliant intellectual band could not be. Beginning work in the year in which, through Kekulé's inspired genius, benzene became a living soul, he could overlook an astounding field of discovery. The romance of the story was beyond words one almost transcending imagination. Moreover, it was all absolute solid fact registered in terms of most wonderful colour, capped by Jade Green. If Mr. Morton had been true to his colours, he would have appeared in Jade Green that night, instead of in a dull black suit. The world strutted in colour but had no understanding of the work. Chemists were a small class apart, content with the content of true achievement, which was ever the best reward, above and apart from any praise or payment. Mr. Morton had a rich reward, he felt sure, in the knowledge of his brilliant success, in addition to the material ways in which the world was showing approval of his work. No man had better reason to be proud of his success ; he had won it because

he had been qualified for the work and with calculated means "Dour," however it was pronounced,* was a word associated with the Scot. People were told it meant "stubborn," or "hard to move." In Mr. Morton's case it had meant "hard at the attack." Throughout his career he had gone steadily forward, always improving. His success in the chemical field recalled that of Perkin. Perkin was always vaunted as the discoverer of the first artificial dye-stuff, Mauve. The discovery was sheer accident; there was nothing in it. Perkin's greatness lay in recognising his opportunity and entering upon the astounding task of founding an industry when a youth of only nineteen; his greatness lay still more in succeeding. Raw materials had had to be found Every operation had been new - at least on the scale on which he had been called to work. Special plant had had to be designed and constructed for each process There must have been something of the prophet in Perkin in those early days to have led his father to put his means into the boy's enterprise and his brother to become his partner and look after the business side He (the Chairman) would show the audience the pictures of father and sons a wonderful triumvirate. Perkin had led the world into fields of loveliness undreamt of before his time but he had made only a modest commercial success of his beautiful foundling and its far more stalwart, light-fast, pigmentary relatives. He was too narrowly educated, too inexperienced in the world, he had no helpers; he lacked the vision to develop and expand his business to the extent necessary to meet the growing competition. He had stolen a march on Graebe but German commercial-scientific solidarity was eventually too much for him. His retirement from the field had also higher reasons. He was no mere maker of goods He was an artist in many ways a musician; he could wield the brush; he was a bit of a Lucullus in early days the tendency was far more marked in his jovial and more worldly brother; he was only led by his piety to become a vegetarian and abstainer in later life, he had wonderful fingers, which he itched to put to further creative use. Above all, the holy fire of original genius burnt within him, so he withdrew to his laboratory and became the physical chemist of high degree, an example for all time There was more than something of the prophet in Mr. Morton. He looked the part one could imagine him preaching a gospel in a Scotch kirk. He had magic personality, the power of attracting disciples who remained not merely his fellow workers but one with himself in a passionate determination to carry their mission to success. His had been a more difficult task than Perkin's He had been called on to do more difficult things at a time when everything was difficult. Still, he had an organisation at his command and faithful assistants. He too, was full of wit That he had business ability was clear; he also had complete technical command of the textile and dyeing industry. He would not say that Mr. Morton understood dye-stuff making technically he did not suppose he could answer a question in an examination -but he was in complete sympathy with its problems, its methods and its difficulties. Obviously, too, he had the research spirit within him his study of fading was proof. In addition, he was a man of high artistic feeling and culture. He had scoured the world in search of colour patterns. If one went to his museum in Carlisle one would see a wonderful collection. He would now pay Mr. Morton his highest compliment. Nothing had struck him (the Chairman) more as a youth, when a student in Leipzig, than the cultured intelligence (largely derived from the University) of the German business man. He had had the entry to several houses there. He had met with nothing of the kind on his return to England and had rarely met with it here in the interval,

*To me it is "dower" -having always at the back of my head the German verb dauern, to last, which must be at its root. I prefer to render it as "lasting, steadfast, trustworthy."

except in houses like that of the late Dr. Mond. Dr. Mond had made his industry a great success. German industry had always been in the hands of technically qualified directorates. We had too often courted aristocratic failure. The Dyestuff industry had been a failure in this country from the time of Perkin up to the war, because it was never in the hands of business men of sufficient intellectual calibre, culture and sympathy. We should hold our fair share of the industry only so long as such men had charge of its ways and means. Chemists might come, chemists might go—they were indispensable—but a wide charity must also be operative to make an industry succeed.

He had felt it a great privilege during the past dozen years to have had Mr. Morton as a friend ; to him he had been an intensely interesting study. To chemists he brought a lesson of the greatest consequence. They might have played their part at any time. Some had long held that English failure to maintain an organic chemical industry had been due to lack of leadership on the commercial side—to lack of intelligence in our business men. Mr. Morton had proved that to demonstration but in so doing he had given a warning. He had developed only a section of the industry. The larger section had been encouraged into a passing prosperity by entirely artificial means. No mere combine would sustain it. Complete and undivided technical efficiency of management alone would secure its continued success. For chemists it was an anxious time: they were accustomed to weigh and measure and were not without ability to read even a commercial barometer.

Mr. H. T. Tizard, C.B., F.R.S. (Permanent Secretary, Department of Scientific and Industrial Research) said he need hardly tell the Chairman, at any rate, that personally he knew nothing whatever about the subject. He had attended the meeting because of his general interest in the matter, and also because the very high reputation of the lecturer had even reached one, in the person of himself, who knew very little about organic chemistry. All he could say, after having listened to the lecture, was that not one minute of one's time had been wasted. Mr. Morton had given a magnificent record of one of the greatest achievements of modern times. He could not help feeling that if the country had a few more like him the depression which was so apparent today would not be there. He had happened to note one or two remarks of Mr. Morton as he had been delivering his lecture, and he did not think he could do better than repeat them. The first, which had a bearing on the recent remarks of H.R.H. the Prince of Wales, was "Our firm had behind it a long-standing reputation for reliable goods. . . . It was at this time I made an exhaustive tour personally among our customers." The next quotation he desired to make—and one which he would like to see written up everywhere—was, "I was adverse then to inviting outside capital for a kind of business that had so many risks, and which even now might only be temporary." Finally, and the greatest quotation of all, and one which earned everyone's respect and admiration, because it showed the lecturer's courage and long-sightedness : "If our chemists were not needed for production they could research, so in these two adverse years, though we drew in our horns in many ways, we did not dispense with the services of a single chemist." He thought he need say no more, because nothing he could say could really enhance Mr. Morton's reputation. He could only conclude by saying how glad all those who had the interests of the country at heart must be that Mr. Morton had not suffered through his courage, and through putting into his business all that he had to put in.

Mr. G. P. Baker, who is connected with the dye industry as applied to textile printing, said he had attended that night to pay his tribute of appreciation

to Mr. Morton, whom he had known for very many years, and whom, after having listened to the paper, he admired more than ever. It was a wonderful story which Mr. Morton had told. What an incentive it was to the young chemists of the present generation. His own days of energy had departed, but he desired to emphasise what Mr. Morton had said—that before every young man there must be an ideal—something towards which he must aim ; an ideal such as Mr. Morton had had after seeing his goods in a window damaged through no fault of his own. He thought that the niche in the wall of that hall of honour which had been mentioned was still reserved for James Morton, and that his bust would be found there some day. Britons were proud of Mr. Morton ; he had forged the most important link in the chain of the dye industry of this country since Perkin's day. That in itself was a great achievement.

MR. T. C. DUGDALE remarked that it was well known generally that the pioneer work which had been done by Sundour had been eminently valuable all over the textile trade. Scottish dyes had saved the country during and after the war. From that point of view, had it not been for the lecturer, probably the country would have found itself very badly wrecked as far as fast colour was concerned, because it had been impossible to get any sound dyes from Germany, the Government having seen fit at one time to debar them entirely. It had been the fact that Scottish dyes had been originated by Mr. Morton which had saved the situation for all textile people. For that reason alone every chemist and every artist who had any connection at all with the textile trade should be extremely grateful to Mr. Morton. The paper contained a history of the subject which it was well worth while everyone digesting at leisure.

MR. J. GUILFOYLE WILLIAMS said he was engaged in a large departmental store in London and had been very interested in that part of the lecture dealing with fast dyes. Perhaps a few remarks from the consumer's point of view might not be out of place. He found that the term "guaranteed fast dye" was used sometimes in a very loose sense either by the manufacturer, the buyer, or the wholesaler of the cloth. At least 15 per cent. of the samples which were submitted to him by the buyers of the organisation with which he was concerned were not fast dyes ; a number of them were ordinary cotton dyes, and some of them were very fugitive. He thought there was need for education of the buyers and of the public concerning fast dyes. For instance, he had recently been told by a buyer that he did not really see much point in the Vat dyes, as he had been told on excellent authority (a traveller in fabrics) that Vat dyes were simply ordinary dyed fabrics which had been washed until no more colour came out.

THE CHAIRMAN, interrupting, said he did not think the meeting could enter into a general discussion of fast dyeing that evening.

MR. HENRY G. DOWLING said Mr. Morton had stated that those concerned in the matter must study the science of selling. That was an echo of what the Prince of Wales had said that week. Mr. Morton certainly seemed to be a prophet with a message. The story of the adoption of the trade mark had been most interesting. It showed the value of a good trade mark and a good slogan in business. He himself also desired to emphasise the importance of personal contact with customers. If principals of businesses would get into direct contact with some of their customers and endeavour to get to know the requirements of their customers it would be better for trade generally. Another point in the lecture which had interested him

was that which referred to the value of science schools. He was certain that was a point which appealed to the Royal Society of Arts—which was a Society for the promotion of arts and commerce. Another very great point was the value of idealism in business. Mr. Morton had had an ideal, and to a young man like himself that had appealed to him. Another matter from the political point of view was that of the value of safeguarding. He was not conversant with the chemical formulæ and processes involved, but it was interesting to him to know that many of the names which were frequently used when discussing dye colours owed their origin to Mr. Morton's work. He also could not help feeling that Mr. Morton had been somewhat inspired by that great man, William Morris, who, whatever he attempted, mastered, finding pleasurable delight in the hardest of work. Morris insisted on his own complete absorption in his work. He also insisted that the materials which he employed should be sound and durable, and, he believed, also made his own dyes. As a young man he was proud to have listened to the lecture. Mr. Morton had referred to "the beneficent trust." It was a surprise to him that under a trust or combine individualism was still possible.

Mr. M. Atkinson Adam said he had listened with very great interest to the lecture. Nothing but Mr. Morton's indomitable driving energy could have carried him through his initial difficulties He had had the privilege of visiting Mr. Morton's works in Carlisle in 1915, and to have seen the beginning of the development of Mr. Morton's dye production. At that time he had been very much afraid for the successful accomplishment of the effort on which Mr. Morton had started, as it seemed so extraordinarily difficult. He had watched Mr. Morton's efforts throughout the years, and had been more and more struck with his vision, and his idealism, and with the powerful driving energy by which he secured the accomplishment of his aims in face of all obstacles.

Dr. Thomas Jones said the last speaker had referred to the fact that he had visited the Carlisle works in 1915, but he himself had had the prouder privilege of having visited the tomato house at Penrith, and he remembered quite distinctly the exposed cards of yarn. The "Flodden Field" was very vivid before his mind's eye now. It was quite true that Mr. Morton was a man of remarkable driving energy and of vision, and of all the other qualities with which he had been credited that night, but nothing had been said about Mrs. Morton or the family, and what they had had to endure, and he was almost inclined to ask the meeting to pass a vote of sympathy with Mrs. Morton and the family at having had to live with Mr. Morton—or, rather, to have had to live without him! His first sight of Mr. Morton had been in a small room in which the Forty Club met in Glasgow—he supposed about thirty years ago—and Mr. Morton had on that occasion been reading a paper on William Morris. That might interest one of the previous speakers who had referred to William Morris. Might he make one appeal to the Chairman? Would he ask the chemist who had been referred to several times during the lecture (Dr. Thomas) to stand up so that everybody might see him.

(Dr. Thomas stood in his place and was given a hearty reception by the meeting.)

Mr W. K. Beaumont said, as one who was particularly dealing with the selling of the lecturer's goods, he would like to ask whether the new process of producing the dyes would make Sundour dyes absolutely fadeless. He had had experience with guaranteed fabrics, and some of them had been returned to him as having faded. There were very few such occasions he would admit, but he would like

to know whether in the future the dye industry would produce absolutely guaranteed fadeless dyes, and whether that fadeless guarantee would extend for more than, say, two years, or if there was any limit to the lasting of Sundour dyes.

Dr. Arthur Hopwood said the Chairman's remarks with reference to Professor Perkin were quite exemplified in Mr. Morton also. Mr. Morton's father had been very similar indeed to Professor Perkin's father - a man of outstanding ability and a pioneer in many directions. The great fact which he had noticed about Mr. Morton was that he never allowed any difficulty, however big, to stand in his way. As a textile man he had been confronted with the difficulties of getting dyes during the War, and had reluctantly to switch over to the work of a chemist to make dyes himself by most complicated processes, and yet he had carried these out in a most remarkable manner. Another point not so well known was that Mr. Morton sent his workers to a School of Chemistry in Carlisle to receive their education there, and also paid their fees and wages whilst they attended the classes. Three other textile firms did the same in Carlisle, which was a very fine example to the rest of the manufacturers in the country.

The Chairman, in moving a vote of thanks to the lecturer, said the lecture would in a measure - but only in a measure—help the world to understand what had been done. The story could not be told in a way to bring it fully home. It was apparently only at intervals that the people of the world got such men of genius as Mr. Morton coming up amongst them. To those present it must have been a great pleasure to see a genius for once in their lives.

The vote of thanks was carried unanimously.

The Lecturer, in acknowledging the vote, said the remarks which had been made about him had been much too flattering. One speaker had asked a very pointed question which he had better answer—about the fastness of the dyes. As he had said in the paper, in all his firm's efforts to get fast colours they had aimed at what was called practically fast dyes. The audience would have gathered that the effort he had made had been in the nature of a protest against something which had been entirely wrong. There had been something almost immoral in the things which had been done, and his effort to get a new standard of colour had been in the nature of a protest. Ever since then his firm had been aiming step by step to get to a still higher point. They had got some colours that really might be called absolutely fast if they were properly dyed and properly handled; but, as was well known, in the course of about a half a dozen processes where the human factor came in there was an opportunity of something going wrong. In all guaranteed goods one had to take account of the human factor which might have made a slip. In the early days of Sundour the firm had laid aside a sum out of profits against complaints which might come in; but it had been found that the number of complaints had been so infinitesimal that that reserve had been abandoned altogether. They had found that by using the very best colours known, and dyeing them in the best possible way, the number of complaints had been really infinitesimal. He was certain that if dyers took the utmost advantage of what was now available, the trade would never have complaints on that score. It was the fact that some dyers took advantage of using less good materials, which made the bad impression.

He would like, before he sat down, to say how very pleased he was that Professor Armstrong had taken the chair. From the first occasion when he had visited him, in 1915, Professor Armstrong had taken a profound interest in the development of

the work, and had been an enormous stimulus to the young chemists of the firm. He would ask one or two of them out to lunch in order to talk over things, and one could hardly realise how much that helped in the early stages of the work. He could not be too grateful for the very keen interest which Professor Armstrong had always taken in the matter, and he desired to close by asking the audience to pass a hearty vote of thanks to Professor Armstrong for presiding.

The vote of thanks was carried unanimously, and the meeting terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 15. Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Informal Meeting.
At the University, Liverpool. 7 p.m. Annual General Meeting.
At the University, Edmund Street, Birmingham 7 p.m. The Hon. Sir Charles A. Parsons and Mr. J. Rosen, "Direct Generation of Alternating Current at High Voltages."
Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m.

TUESDAY, APRIL 16.. East India Association, at Caxton Hall, Westminster, S.W 4.30 p.m. Colonel Sir T. Carey Evans, "Health Progress in India."
Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Prof. C. Bresciani-Turroni, "The Movement of Wages in Germany during the Depreciation of the Mark and after Stabilisation (1920-28)."
Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Mr. R. Bell, "Transport Developments in 1928."
At the Queen's Hotel, Birmingham. 6 p.m. Annual General Meeting.

WEDNESDAY, APRIL 17.. Civil Engineers, Institution of, Great George Street, S.W. 6 p.m Mr. E. T. Painton, "Problems involved in the Design of Overland Transmission Lines."
Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr. F. H. Rosencrants, "Practice and Progress in Combustion of Coal as Applied to Steam Generation."
At the Cleveland Technical Institute, Middlesbrough. 7 p.m. Annual General Meeting.
Food Education Society, 29, Gordon Square, W.C. 3 p.m. Mr. C. E. Hecht, "Aids to Fitness."
Metals, Institute of, at Thomas' Café, Swansea. 7 p.m. Annual General Meeting.
Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. The late W. H. Dines and L. H. G. Dines, "Monthly mean values of Radiation from various parts of the Sky at Benson, Oxfordshire" (Vol. 2, No. 11). 2. Mr. L. H. G. Dines, "An Analysis of the Changes of Temperature with Height in the Stratosphere over the British Isles" (Vol. 2, No. 18). 3. Mr H. A Hunt, "A Basis for Seasonal Forecasting in Australia."
Microscopical Society, 20, Hanover Square, W. 7.30 p.m. 1. Professor Dr. E. Ghosh, "Two New Suctoria from Sewer Water." 2 Messrs. P. L. Li, H. S. D. Garven, and R. Howard Mole, "The Microscopic Anatomy of the Vascular System of the Dog's Spleen." 3. Mr. D. S. Spence, "A Method of Finding the Refractive Index of a Drop of Mounting Medium"
United Service Institution, Whitehall, S.W. 3.30 p.m. Lt-Commdr. J. J. C Irving, "Coronel and the Falklands"

THURSDAY, APRIL 18 . Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 6.30 p.m. Colonel V. C. Richmond, "R101."
Antiquaries Society of, Burlington House, W. 5.30 p.m.
Automobile Engineers, Institution of, at the Technical Institute, Guildford. 7 p.m. Mr. H. W. Pitt, "Central Lubrication of Chassis Bearings."
Electrical Engineers, Institution of, Savoy Place, W.C 6 p.m. Mr. R. A Chattock, "The Modern Use of Pulverised Fuel in Power Stations."
At Trinity College, Dublin. 7.45 p.m. Mr. J. D. Ferguson, "Electric Time Signalling"
Linnean Society, Burlington House, W 5 p.m.
Mechanical Engineers, Institution of, at Halifax 6.45 p.m. Mr. J. G. Stirk, "Modern Machine Tools."
Mining and Metallurgy, Institution of, at Burlington House, W 5.30 p.m.

FRIDAY, APRIL 19.. Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m. Lt.-Colonel J. T. C. Moore-Brabazon, "Early Aviation."
Dyers and Colourists, Society of, at Milton Hall, Manchester. 7.30 p.m. Annual Meeting.
London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. The Right Hon. Sir William Bull, "London and the Channel Tunnel."
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. W. Reavell, "Keys and Keyways."
Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Prof. P. W. Bridgman, "The Properties of the Elements under High Pressures." (Guthrie Lecture.)
Royal Institution, 21, Albemarle Street, W. 9 p.m. Professor Owen T. Jones, "The History of the Grand Canyon, Yellowstone National Park."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C (2.)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 22nd, at 8 p.m. (Aldred Lecture.) SIR E. DENISON ROSS C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic Movements in Asia." (Lecture I).

WEDNESDAY, APRIL 24th, at 8 p.m. (Ordinary Meeting.) LYNTON FLETCHER, B.A. (of the British Broadcasting Corporation), "Recent Developments in Educational Broadcasting." PROFESSOR T. PERCY NUNN, M.A., D.Sc., Litt.D., will preside.

COUNCIL.

A meeting of the Council was held on Monday, April 8th. Present: Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Mr. Llewelyn B. Atkinson, M.I.E.E., Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Alexander Gibb, G.B.E., C.B.; Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.; Col. Sir Arthur Holbrook, K.B.E., M.P.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Sir Henry A. Miers, F.R.S.; Sir Richard Redmayne, K.C.B.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas, and Sir Frank Warner, K.B.E., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society:—

Abbott, Stephen Shapland, Southall, Middlesex.
Ali, A. Yusuf, C.B.E., London.
Atkins, Henry Kent, London.
Bodley, Frederick Charles, Ontario, Canada.
Catchatoor, T. N. Joseph, Rangoon, Burma.
Cooper, Arthur Thomas, M.Inst.C.E., London.

Cramp, Charles Courtney, London.
Dart, Edward N., Pelham, New York, U.S.A.
Delfos, Cornelis Fredrik, Pretoria, South Africa.
Fielding, George William, Ashton-under-Lyne, Lancs.
Gibson, Norman R., Niagara Falls, New York, U.S.A.
Glass, Frederick James, Doncaster.
Godson, G. Bird, London
Hashmi, M. Nasiruddin, Hyderabad, India.
Heasman, Arthur William, M.V.O., O.B.E., London.
Heylin, Henry Brougham, O.B.E., Tilehurst-on-Thames.
Jatia, Kanai Lall, Calcutta, India.
Lang, John G., Saltash, Cornwall.
McDougall, Charles, London
McGowan, Sir Harry, K.B.E., London.
Olsen, George Frederic, Los Angeles, Cal., U.S.A.
Patrick, William Thomas, J.P., Guildford, Surrey
Ramey, Blaine, B., Towson, Maryland, U.S.A.
Rau, Ramanathpur Subba, Bombay, India
Reynolds, Lyn, Hyde, Cheshire.
Warburton, Percy, High Lane, Cheshire
Watson, Alexander Silver Foord, Fallowfield, Manchester.
White, Thomas G., Seven Kings, Essex.

The thanks of the Council were accorded to Sir Charles Wakefield for his donation of £500 to the Fund for the Preservation of Ancient Cottages.

The Chairman of the Council and Mr. P. Morley Horder, Chairman of the Executive Committee of the Fund for the Preservation of Ancient Cottages, were authorised to sign the contract for the sale of West Wycombe and to affix the Society's seal thereto.

Further consideration was given to the question of the award of the Albert Medal for 1929.

Preparation of the Balloting List for the new Council was begun.

A quantity of financial and formal business was transacted.

SEVENTEENTH ORDINARY MEETING.

Wednesday, April 10th, 1929. Sir Richard A. S. Paget in the Chair.

A Paper on "Some Modern Aspects of Electrical Communication," was read by Mr. G. H. Nash, C.B.E., M.I.E.E., European Chief Engineer, International Standard Electric Corporation. The Paper and discussion will be published in the *Journal* on June 7th.

INDIAN SECTION.

Friday, April 12th, 1929. Sir Stanley Reed, K.B.E., LL.D., in the Chair. A paper on "Recent Electrical Developments in India," was read by Mr. A. T. Cooper, M.Inst.C.E., M.I.Mech.E., M.I.E.E., M.Cons.E. The paper and discussion will be published in the *Journal* on June 14th.

PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 27TH, 1929.

DR. L. A JORDAN, D.Sc., F.I.C. (Director, Research Association of British Paint, Colour and Varnish Manufacturers) in the Chair.

The following paper was read :—

EAST INDIAN COPALS AND DAMARS.

By A. F SUTER.

INTRODUCTION.

Resins are, with one important exception, of vegetable origin, formed by the oxidation of natural or artificially stimulated exudations from certain plants. The exception referred to is shellac, which, instead of exuding from the plant, has to pass through the body of an insect attached to the plant.

The *resins* are, therefore, closely allied to such botanical products as latices, vegetable waxes, gums and wood oil ; in fact, there are quite a number of intermediate products, containing two or more of these exudations in mixture. A very large number of plants of various natural orders produce resins. These differ in their characteristics comparatively little, but not all of them have attained economic value.

The *distribution* of resiniferous plants is world-wide, extending in both hemispheres from the equator far down into the temperate zones. Copals and damars are found right through the Far East in a broad belt along the equator and again through the African continent. In the southern hemisphere, New Zealand, between 40 and 50 degrees of latitude, is the home of the Kauri resin, and similar copals occur in Northern South America, Brazil and along the Andes to points much further south. In the northern hemisphere, resins are collected largely round the Mediterranean and Central Europe, while the pine forests of North America are responsible for enormous quantities of oleo-resins

As I have stated, not all of these resins are collected and employed in industry. Of those known to commerce, the two chief groups are the *copals* and the *damars*. The resinous products of the various pines are grouped by themselves, since they mostly do not come into commerce in their raw state, but are distilled into spirit of turpentine and rosin at the source of production. Among the *minor resins* are best known sandarac from Morocco and Southern Australia ; mastic from Chios and the Levant generally ; red and yellow accroydes from Southern Australia, and benzoin from the East and West Indies.

The grouping of the major resins into copal on the one hand and damar on the other, is somewhat arbitrary but quite useful, being based upon the difference of their physical characteristics. It is with these two groups that we shall chiefly concern ourselves to-night.

The copals of commerce comprise the following resins, given with their botanical origin and chief country of collection :-

Macassar, or Manilla Copal	*Agathis alba Foxw.*	Dutch East Indies.
Kauri Copal.	*Agathis robusta.*	New Zealand.
Congo Copal.	*Copaifera* and *Trachylobium spp.*	Belgian Congo.
Zanzibar or Lindi Copal.	*Trach. Hornimanniana.*	Zanzibar, Madagascar and East Coast.
Mozambique or Inhambane C.	*Copaifera* species.	Madagascar and East Coast.
Sierra Leone Copal	*Copaifera Guibourtiana*	West Coast Africa.
Angola (Benguela) Copal	*Daniellia* species.	West Coast Africa.
Demerara Copal.	*Hymenea Courbaril* (Locust tree).	West Indies and Central America.

Of these resiniferous trees, the *Agathis alba* and *A. robusta* belong to the order of the Coniferae, all others to the order Leguminosae, sub-order Ceasalpiniaceae.

The damar-producing trees all belong, as far as is known, to the rich and varied natural order of the Dipterocarpaceae, chiefly the genera *Shorea, Hopea, Balanocarpus, Vatica* and *Vateria.* They are all indigenous to the tropical belt from Ceylon eastward to New Guinea and are collected very largely in Sumatra, Borneo and the F.M.S.

I may mention to you now that the name copal, which is Mexican for resin, is unknown to the natives in the East. Both groups, damar and copal, are called damar, the Malay name for resin or a torch made of resin.

In Europe, commercially, the true description resin is seldom applied to these substances ; they are erroneously called gums, on account of their physical similarity to the true gums.

COPALS.

Of the various copals known to commerce, the one to concern us to-night is the *Macassar or Manilla Copal.*

This type of copal has its origin in one single plant, the *Agathis alba Foxw.*, and it occurs most frequently in the Dutch East Indies ; in Celebes, the Moluccas, Borneo, Sumatra and New Guinea. The tree also occurs largely in the Philippines, where it is exploited and in the Malay Peninsula, where the resin is, however, not collected. The tree does not exist in Ceylon or British East India, nor further west in the same latitudes.

The tree is, in the wider sense, a member of the Conifera, and is grouped with the Auracarias, of which family all of us know at least one member, the monkey puzzle. And really this curious tree is not unlike to the *Agathis alba*. I will show you a few pictures of a row of these trees which stand in the grounds of the Forestry Department in Buitenzorg, Java. These are about 25 years old and probably about 50 to 70 feet high. On the other hand, in the virgin forests of Central Celebes, I have seen many specimens of about 200 feet high and said to be probably over 500 years old. Those of you who have seen the flag staff in Kew Gardens may obtain a good idea of the height of a full-grown copal tree, since this mast (the bole of a Douglas fir) is just about 200 feet high

The *Agathis alba* does not favour ground near the seashore, but prefers altitudes from 1,000 ft. upwards, and flourishes well at much higher altitudes. You must, however, not imagine forests of copal trees as we have forests of pines or spruce or other conifers in Europe or America. These trees occur singly or in small clumps, very often barely 100 to the square mile and at times as few as a dozen In the thick tangle of the undergrowth, and the generality of the forest being somewhere between 60 and 100 ft. high, the *Agathis* trees

*A row of young *Agathis Alba* at Buitenzorg in Java.
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are not easily to be seen from below. If, however, you stand on a height, overlooking a large stretch of forest, the closely woven canopy is dotted all over with the *Agathis* crowns which stick out far above the general level. As you have seen, these cylindrical crowns are easily recognisable at a distance. The forests are so dense that, in order to visit the trees, you have to follow perforce the paths made by the copal tappers or hack your way through the tangle of tropical growth.

**Agathis Alba*, 180ft. high in Malili district

For the description of the tree, after seeing the pictures, it will suffice to say that the bole or trunk is perfectly round and nearly the same thickness all the way up, very straight and usually provided with branches only on the upper third. The bark is quite smooth and of an impressive greyish brown tint, much like the plantain trees one sees so often in English towns. This similarity goes further still in so far as the copal tree bark also renews itself in more or less round flakes or whirls, showing at first a beautiful brick-red below.

The tree is bi-sexual, carrying both male and female flowers, the male being small catkins. The fruit is a flattish cone, bright green until maturity

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in two years. The seeds are placed each in the centre of a fly-leaf for distribution purposes. The leaves are in appearance greyish and of a leathery texture, much like the leaves of mistletoe. The branches, being placed nearly vertically, give the crown its conical shape. It is only at very high altitudes that the crowns appear somewhat flatter. The root system consists of an enormous tap root with a ring of wide-spreading surface roots. The system is almost always completely buried, and I have in no case seen buttress roots as are so common with damar trees.

In comparison with the Kauri pine in New Zealand, the *Agathis alba* is in no way behind as far as height is concerned, but in point of circumference or diameter, the Kauri pine is said to be three times the size. Yet the *Agathis alba* is probably one of the biggest timber trees of the Indies. If it be possible to judge the age of a tree by its year-rings, then the biggest Kauri pine has been found to be 2,400 years old; while the *Agathis* forests of Malili in Celebes show no trees older than 500 years The growth of these trees is by no means as rapid as one might be led to believe by their size; in this respect the *Agathis* is comparable to *Tectona grandis*, the teak tree, the timber of which is known to all of you Although not of the value of teak, the *Agathis* timber is also employed for many purposes locally. It is perhaps unfortunate that a tree which yields such a valuable forest product, should at the same time be a valuable timber tree, but you will find the same combination applying to the damar trees.

The Resin. Copal is a natural exudation from the bark of the *Agathis alba* at places where the latter has been injured, by accident or design. It has been definitely found that resinosis, that is, the process of the production and exudation of the resin, takes place only in the bark. When a piece of bark is removed from the trunk, innumerable tiny drops of a sticky liquid begin to exude at once. In colour these are very pale, some clear and some opaque. In a few days they have grown to long streaks down and below the area from which the bark has been removed, and have hardened on contact with the air to such an extent that they can be removed quite easily. This polymerisation to a hard substance naturally chokes the wound and stops the flow, but when the resin is removed and the wound scraped afresh, the flow starts again.

What purpose the resin fulfills in the process of vegetation seems something of a mystery still. It has been argued one way and the other by the botanists, and purposes have been ascribed to it of which I believe it is quite innocent; personally I find it difficult to change my opinion that the sole purpose of the resin is one of protection against damage of any kind, in which case it would be of pathogenetic origin.

Foxworthy distinctly states that "occasionally pieces of wood very densely impregnated with resin are found, these being nearly always small, very heavy and very dark in colour." Van de Koppel, on the other hand, asserts that

during the whole of his stay in the copal forests of Malili he had never found any resin ducts in the wood, either sap or heart. I mention this because, the resin never being found in the normal process of vegetation, it is specially manufactured in times of need, *i.e.*, protection to the tree. It may be as likely, therefore, to occur in the sapwood immediately below the cambium as in the inner bark, provided the damage to the tree has been sufficiently deep to provoke this pathogenetic process

Tapping Methods. Before I enter upon a full description of the present day methods of exploitation and cropping of copal, I ought to give you an idea of the various kinds of copal of the Macassar type known in trade They are :—

*Bole showing correct tapping.

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(*a*) Hard or fossil copal, of unknown but often very great age, and very hard.
(*b*) Half-hard copal, less hard and much younger.
(*c*) Soft or spirit-soluble copal.

Type *a* is found either in the crotches of branches in old trees or else dug from the ground at the foot of old trees or where trees at one time existed. Types *b* and *c* are of recent origin and are obtained by the removal of portions of the bark from living trees.

In the forests of Malili, where the tapping of copal trees has now been practised as a well-regulated industry for years, the method of tapping the trees has become very uniform, owing to strict supervision by forestry officials. These foresters have to enforce the stringent rules and regulations in order to prevent the heavy over-tapping which took place in earlier years and was the direct reason for the extensive mortality among the trees.

In Malili there are reckoned to be about 200,000 copal trees spread over perhaps 2,500 square miles, and leased for exploitation to about 1,500 natives. The trees are leased by the Government to the natives in batches of 50 to 200. The native undertakes to tap the trees according to the regulations in force, any serious transgression or the death of trees through over-tapping being punished by forfeiture of the lease or even imprisonment.

In this district, the tapping is done in the following way: a horizontal cut is made with a heavy knife through the bark to the wood of 15 to 30 cm. length, and the bark is removed in the form of an apron below this cut. The exudation from the cut flows over the wood and, therefore, remains clean. The wound is renewed in an upward direction about one month after the first tapping. The fresh exudation trickles over the first accumulation and hardens into a big lump of copal. One month later the third enlargement of the wound takes place to re-start the flow At the end of three months the accumulation of copal is removed from the tree, broken up and carried away by the tapper. This product, therefore, consists of a mixture of copals, some three months, some two months and some one month old. It has been found in practice that copal exposed to the atmosphere on the tree for more than one month loses its alcohol solubility completely, so that this accumulation consists of somewhat under one-third of spirit soluble or soft copal, and the rest of half-hard copal. It demands an exceedingly practised hand to distinguish the two kinds from one another, when it comes to sorting the copal, and those of you who manipulate these two kinds in practice will readily recognise in this method the origin of some of your troubles.

I have samples here of exudations of one day; one, two and three weeks; and one, two and three months old. In solubility, they behave as they would be expected to, except the one-day-old stuff, which is perfectly soluble, but fails completely as regards viscosity, giving a solution as thin as if turpentine had been added to the alcohol.

Now it must not be supposed that the considerate method of tapping as described above has always been in use by the natives. It will astonish most of you to hear that extensive tapping of living copal trees did not become a common practice in Celebes until about 1916, although it was known and, to some extent, used, on some of the Moluccan islands, particularly Batjan, Ternate and Great Obi Once the native discovered that the exudation had commercial value and could easily be sold to traders in the coast settlements, he quite naturally set to work with a very heavy hand. The more wounds he cut into a tree, the more copal exuded, at least for a time. The results of such excessive tapping are most horrible to behold; to a man who loves trees, the sight is as pitiful as that of deformed or crippled humanity.

*Incorrect tapping, showing many badly healed wounds

Thousands of trees became hollow, died and snapped off, a yard or so above the ground. About 1918 the first steps to check this terrible waste were taken by the Central Government in Java, strict tapping regulations being issued through the headmen, but it was found impossible to impose

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observance of these regulations and restrictions by the natives until five or six years later, when a forestry official was stationed in the Malili district, who was given the means to enforce the regulations.

But even today, in the light of what has gone before, it is difficult to say what is wise and what is overtapping. Trees occasionally still die off; whether as a direct result of the tap wounds or not, cannot be determined yet. Two points, however, have been settled; one, that the least possible area of bark should be removed from the tree, and, two, that the total length of the horizontal cuts must not exceed one-half of the circumference of the tree. The Government regulations prohibit the tapping of trees of a girth less than 1.50 m. in Celebes and 1.75 m. in the Moluccas. Nor must the tapping be carried higher than 2.50 m. from the ground.

Yield of Trees. Up to recent years very erroneous opinions of the yield of the copal trees existed. These were based probably on native statements, which notoriously tend to exaggeration. Since, in Malili, trees are now farmed out in definite numbers of 50, 100, and 200 to each tapper, much more reliable figures have been obtained lately, but even here very large variations have been observed, namely, between 8 and 40 picols per 100 trees per annum. The highest yields have been shown in the area between the Matano and Towoeti lakes, by trees with a very large diameter and growing in very rich soil. The lowest yields are given by trees in very arid soil and of smaller diameter. Van de Koppel gives the figures of 12 kg. per tree as an average in the Malili district.

Collection and Transport. You must remember that before about 1916 tapped copal was unknown in Celebes; the only copal gathered by the natives was the fossil kind, dug from the ground, or the white boea, found in much smaller quantities in the crowns of the trees. Generally speaking, as long as the varnish maker was the only consumer, the demand was not sufficient to encourage the natives to any systematic search. Later, when the values increased through a fuller application in new industries, it was soon found that the stores in the earth were not inexhaustible. Also, experienced climbers were not always at hand to fetch the fine white lumps occasionally visible in the crowns from a height of 100 to 150 feet. Not all natives care for climbing. In this way hard copal became scarcer and dearer. Macassar still exports both grades, but in small quantities as compared with a decade ago.

To-day, with the tapping of copal established as an industry, conditions have naturally changed. It has been found that certain tribes, sometimes not even of the district, take more kindly to tapping than others. They are employed for this purpose by the leaseholders who are resident. Other tribes, of a more wandering disposition, make excellent carriers and are, therefore, entrusted with the transport of the copal from the seat of production to the nearest marketing place. But, strange to say, in Celebes there are large numbers of pack horses in existence and they are extensively employed

in the transport. In the Malili district, round the two big lakes, the copal is taken to the nearest shore station on one of the lakes and from there by canoe as far as possible; then by land transport again to the port. The journeys from the centre of production to the coast port may take up to a week. From here the coastwise traffic picks up the material and delivers it to the buyer in Macassar, who may be a European firm or a Chinese or an Arab.

*Copal carriers in Celebes.

Although much of the copal is partly or wholly graded in Malili, and may actually be exported from there, the major portion of the supplies find their way to the copal traders in Macassar, no matter whether they come from the Malili district or the Toradja country or the surrounding islands. By this time the copal has passed through probably four different hands.

You must remember that, although the supervision of the forestry department has a powerful effect upon the industry, this is in the first instance directed towards the protection of the trees; the standardisation of the product is a contributory but secondary consideration. The product remains a forest product; therefore, in point of quality, not comparable to a definite culture, such as rubber or tea.

The ultimate exporter in Macassar comes into possession of the copal in various ways. He may have a note from a Chinese dealer to say that sample bags of a new arrival were being shown at these stores; would he come and inspect them? The exporter will do so and leave with the Chinese a bid for the lot in a sealed envelope. Such inscription sales are very frequent, at least once a fortnight, and for lots varying from a few cwts. to several tons. Or the exporter may send his own buyer up to Malili or Polewali or Mamoedjoe to buy the copal on the spot and send it down direct to him by

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steamer. Another and less natural method of trade has sprung up during the years of high prices, a system of cash advances by the exporting house to the chiefs of certain districts. By this means the quantity of copal certainly increased largely, but the quality gradually suffered badly, and in the end the exporting houses who started this method had to write off very large losses.

Preparation and Sorting. We have seen that the supplies of copal are received at the centre of ultimate export in a very mixed condition. Not only are soft and half hard grades always caked together into a block, but at times there are also found in the block pieces of fossil copal which have accidentally been found in the forest. It is, therefore, necessary to separate the various grades.

*Copal grading at Macassar.

The block is smashed first of all with a wooden mallet into smaller pieces, and disintegrates along the lines of adherence between harder and softer pieces. The palm leaves which have served as packing are removed. Around a large heap of this material in the godown (a corruption of the Malay word "goedang" meaning a shed) are squatted the sorters. These are mostly always women, native or Chinese, and of all ages. The mothers have their babies with them and children begin sorting as soon as they can sit still. I have seen establishments of this sort of over 100 women and girls, with as many children round about them, all happily chatting and chanting while sorting copal with astonishing swiftness.

Some of the women crush the pieces of copal into smaller fragments and pass them on to their neighbours The latter have four or five baskets in front of them, filling each one with a separate grade or size of the fragment. When full, the baskets are emptied into large storage bins.

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Four fundamental considerations have to be observed in the grading of copal; firstly, hardness; secondly, colour; thirdly, purity (absence of extraneous impurities); and fourthly, size. Machinery is never employed, native labour being plentiful and cheap. But the latter has one disadvantage. It is exceedingly difficult to induce any of the sorters to change their method, their movements becoming completely automatic once they think they have understood the meaning of the work The children are taught sorting not so much by the overseer as by their mothers. Very early they detach their mental processes from the work in hand, being swift enough with their fingers, but miles away in mind. This fact may explain the apparent excess of labour expended on this operation I have observed that a greatly superior number of grades is sorted by the women than ultimately appears in the European markets These grades are later re-incorporated into a certain definite number of standard grades and then packed in cases, baskets, or bags for export.

Certain regulations regarding the health of the sorters are in operation in Celebes, pulmonary diseases produced by the prevalence of fine dust being feared. Often the women powder themselves thickly with rice powder to prevent the copal dust entering the pores of the skin and spoiling their complexion.

The *hard* copals, Malay name Boea, are sorted according to their size into five grades from A to E, although various colour standards are also in existence. The preparation for export in their case simply consists in removing the weathered crust by a sharp knife.

The *half hard* copal, Malay name Loba, is also assorted into five grades, A to E, according to size, but variations in colour are responsible for a number more.

The *soft* copals, Malay name Melengket, are sorted in the first instance according to their purity, as they usually contain more or less wood, bark or other impurities. The assortment originally was.

No. 1. Free from wood.
2. Very moderate amount of wood.
3. Fair amount of wood.

But the distinction between the three grades was never sharp enough. Nowadays each shipper runs his own marks and tries to maintain these standards both as regards colour and purity.

Use of Copals in Modern Industry. Copals were up to a recent period exclusively employed for the manufacture of varnishes. The soft copals, being completely or nearly completely soluble in cold alcohol, are employed for the making of spirit varnishes without further preparation. The hard and half-hard copals require to be heat-treated, that is, melted and cooked for some time before they become soluble in drying oils.

Kauri copal finds extensive employment in the manufacture of linoleum,

at least the inferior grades, but it is the half-hard Macassar copals which have come into very large demand during the last decade. On account of their thermoplastic character, they are used for all sorts of pressed and stamped articles in the form of a binder; very often in conjunction with or instead of shellac, with which they share several physical properties. Their di-electric properties, however, are much inferior to those of shellac.

Synthetic products of a character similar to resins are now coming into vogue and it looks as if these forest products were losing favour in some directions, but I believe that, given accurate standardisation of the product, they will be capable of withstanding such competition. However, this is the age of the chemist, so that many of the raw products of nature will depreciate in value in proportion to the usefulness of a synthetic competitor.

DAMAR RESINS.

Many more kinds of damar are known to exist than ultimately come into commerce, but they all are the product of one plant family, the *Dipterocarpaceae*. This family is of enormous importance in the tropical forests of the East Indies and, in parts of its range, notably Sumatra and Malaya, it accounts for perhaps more than a third of the existing trees

The *Dipterocarpaceae* comprise a number of members, and these in their turn, a considerable number of species Speaking of Malayan forests, Mr. Foxworthy has described five species of *Balanocarpus*; 15 species of *Dipterocarpus*; 11 species of *Hopea*; 21 species of *Shorea*; 16 species of *Vatica*, and so on. Now the predominant value of these trees, which are chiefly very large and belong to what is called the first or top storey of the tropical forest, lies in their timber, for which they have hitherto been more exploited than for their resinous exudations. For a long time the resin has been regarded as a secondary and often negligible product, except perhaps in Sumatra. It strikes me as curious that the Forestry Department of the Dutch East Indies should have directed its attention almost exclusively to the collection of copal from the *agathis alba*, it being well known that the commercial varieties of damar suffered from botanical impurity, that is, not coming from one tree species alone.

We have to thank the Forestry Department of the Federated Malay States for the first move in the correction of this defect. Some years back it was decided to keep scrupulously apart the resin from one specie of *Balanocarpus*, to grade it into the usual commercial varieties and to test the various markets with the material. This experiment has now grown into a production of about 100 tons per annum and, I believe, has fully justified itself Some of you present may know the damar, although we in London have never seen much of it so far. I am speaking of damar *Penak*, the product of *Balanocarpus Heimii*.

*Balanocarpus Heimii bole; damar being gathered by native

By far the largest proportion of damar in commerce comes from Sumatra. A very large percentage of the total area of the island is covered with rain forests, and these contain, as I have stated, very many damar trees. Next in importance, at least as far as collection is concerned, comes the Malay Peninsula, including that portion of Siam which is situated on the Peninsula. The forests in Borneo are capable of producing large quantities of damar, but the collection is not so well organised, except in the district of Pontianac, on the West Coast. Java, with her dense population and very high state of cultivation, has little room for primary forests, although Batavia has always been known as the chief grading and distributing port of the finer kinds of damar. In Celebes damar certainly exists in good qualities, but the collection is in its infancy. Ceylon shows no damar exports, although most of the species mentioned are indigenous there. The Moluccas and New Guinea will in time probably add greatly to the world's production.

The methods of tapping damar trees differ largely from those of the *Agathis alba*. You will remember that the copal tappers do not wound the trees higher than a man can reach from the ground, by one cut extending horizontally from one-third to one-half of the circumference, removing the bark below. The damar tapper, on the other hand, appears to make a great many small

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wounds at intervals right up the trunk to the crown. He makes a transverse cut with his parang and then extends the wound upwards notchwise, actually forming a pocket in the trunk. Unlike copal, the fluid damar oozes out of this wound very slowly and in much smaller quantities, forming small nodules, tears and stalactites. The exudations are collected about three months later and the wounds are re-opened. The trunks are invariably too thick for a man to climb unaided. The native, therefore, sets about constructing a ladder by hammering into the trunk small pegs of hard wood or bamboo every two or three feet up the trunk. To these pegs he attaches a length of rattan and his ladder is complete.

Except under Forestry Department supervision in Malaya, damars are usually collected by the native forest population, people of extremely primitive and wild habits still, especially in the more central portions of the islands. Together with other forest products the collected damar is carried down to the nearest village or coast town, if near to the sea, where it passes into the hands of Arabs or Chinese in barter. They sell it to native merchants or to the depots of European firms, by whom the material is shipped to the port, at which it is sorted. Damars from the west coast of Sumatra are usually shipped from the ports of Sibolga, Padang and Benkoelen to Batavia. The East Coast, however, ships most of the material via Belawan, Bengkalis and Palembang to Singapore, this port being nearer. As to Borneo, Pontianac supplies also go mostly to Singapore, but Bandjermasin in the south supplies Batavia. Damars collected in the Malay Peninsula naturally find their way to Singapore, as do those from Sarawak and British North Borneo.

Sorting and Grading. In commerce the view used to be prevalent that there were three different types of damar, and that, in point of quality, they were firstly Batavian, secondly Singapore and thirdly Padang. There is no doubt that the Batavian type, being graded more correctly, had this to recommend it, but to-day we know that all three types are practically identical, seeing that by far the largest supplies originate in Sumatra. Batavia grades the raw material into five different grades, according to size, from A to E, A being the largest particles and E nearly dust. Singapore and Padang grade into three different sorts, according to colour, impurities and, to some extent, also size. The sorting is done by Chinese or Arabs in all three ports, native female labour being employed just as in Macassar. The sorter sells to the shipper at the port, who forwards the material to the usual ports in Europe and America.

Types of damars. Where you have such a vast number of trees supplying the resin, some confusion as to the botanical origin of each type must naturally exist, the collection taking place by natives exclusively. Damar exists in a range of colours from nearly pure white through the whole spectrum to blue-black, both clear and opaque. In size, the small nodules, tears and stalactites of the well-known sorts contrast strongly with that of the inferior

grades, which may occur in very large stalactites or very large lumps similar to fossil copal. It is by no means certain that these larger masses of damar are fossil, although some of them undoubtedly are. In the centre of Java I have been told there exists a hill wholly composed of fossil damar in the form of a nearly solid rock, covered with no more than about one foot of earth on an average. A few tons which have been mined lately are now coming to London for investigation.

Those types which are regularly absorbed by commerce are :—

(*a*) Mata Kuching, the finest white damar, from *Hopea intermedia*. Siam supplies the whitest and boldest. In Malaya the tree is said to die on tapping. Comparatively speaking, only small quantities come into trade, most of the supplies being incorporated into the three following sorts.

(*b*) Batavian, Singapore and Padang sorts, mostly of Sumatran origin, and being obtained from species of *Hopea*, *Shorea* and *Isoptera*, all closely related to *Mata Kuching*

(*c*) Penak damar, collected botanically pure in the F.M.S from *Balanocarpus Heimii* King and graded in a special way.

(*d*) Rasak damar, of a bright yellow colour, often opaque, graded A to E, considerably harder than the former three types. From genus Vatica.

(*e*) Hiroe damar, also bright yellow, from *Vatica* species, from Sumatra, Borneo and the Moluccas.

(*f*) Damar batu, stone or fossil damar This is a collective name for a number of inferior grades of various colours and origin, especially Shorea spp.

(*g*) Damar Hitam or black damar, from *Shorea* species, often containing canarium resin and frequently mixed in fossil and recent form

Of late years, (*e*), (*f*) and (*g*) have also been sorted into five grades, A to E, and they all appear to serve distinct purposes in varnish making.

Use in Modern Industry. Unlike copal, damar has not found any use beyond for varnish making, for which latter, however, it is a very valuable resin. Being completely soluble in cold spirits of turpentine, it produces with little manipulation a highly lustrous varnish, applied largely for coating paper and general use indoors. The darker and harder damars find employment according to their physical properties in varnishes for various purposes. It also finds application in the Batik Cotton dyeing industry.

Generally speaking, the paler the damar, the softer it is. Mata Kuching, Penak and the Batavian, Singapore and Padang sorts are now employed for incorporation into cellulose varnishes. They all contain a small percentage of harder resin than the bulk, which can be precipitated from the toluol solution by the addition of alcohol. This small portion is erroneously called wax, and we hear nowadays of such atrocities as " de-waxed damars." The harder damars are quite unsuitable for this purpose.

TOTAL FROM ALL DUTCH EAST INDIAN PORTS DURING 1926

	Damar.	Copal.
	10,202	15,350
SINGAPORE, ABOUT		
	8,500	1,760

Of the damar exported from Singapore about 2,000 tons are collected in Malay Peninsula, the bulk of 6,500 tons coming to the port from Sumatra and other islands.

Although I do not possess the actual figures for 1928, I can tell you that the exports of copal have increased considerably, whilst damar exports are equally considerably back. It also appears that Macassar is still growing in importance as the premier port of Copal exports, chiefly at the expense of Singapore.

Of these exports, both in copal and damar, the U.S.A. take roughly two-thirds or more. Germany consumes far more damars of all grades than England, but the latter imports much larger quantities of copal.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said it was quite clear that the lecturer had discovered the key of romance in business. One thing which had interested him (the Chairman) was the question of labour in the East. His own experience only went as far as India, and he did not know whether Mr. Suter would count that as being east at all! The labour question was always a trial in those places. It was evidently a great trial in Malaya. In the part of India with which he himself had been associated they had had to employ the women in order to obtain their husbands; and in order to obtain the women they had also to take the children, too. The result was that in even a small establishment there might be as many as 200 or 300 women, and the work done might be singularly small for such a big crowd. All sorts of interesting complications arose therefrom. For instance, at one place he had in mind there were two Lancashire boilers, one of which was in use, the other being kept as a standby. When the time came round to change over from one boiler to another for cleaning out purposes, the first thing which had to be done was to pick out all the babies which had been parked in the tubes of the spare boiler, needless to say, in defiance of all rules.

The lecturer had mentioned the Dutch official aspect of things, and he would be much interested to know whether he had seen that famous agricultural and general experimental station which the Dutch had in Java. One heard many remarkable things about it. There was one extraordinary thing about the Dutch as colonists; they were extremely diligent and they made a very good job. Probably a part of the reason of that was because they had such a small corner of the tropical earth in which to do everything, and consequently there was a very heavy concentration of what was the best of the Dutch culture, and of all those other excellent qualities which went to make successful colonisation. Probably, also that was the reason at the back of the rather disturbing fact that Singapore was losing its position to the Dutch port of Macassar.

Being a curious person, he had to confess that he was rather anxious to know more, if possible, about why a tree made resin. The lecturer had stated that the various authorities said there were no resin ducts in the wood, and suggested that the origin was pathogenic. If it was so, the tree got into action remarkably quickly after being damaged. He was not a botanist, and therefore perhaps it was highly dangerous ground for him to tread upon, but he thought it was generally agreed that much more had yet to be learned about the normal and abnormal processes of tree secretions and growth. There were certain trees which secreted abnormal products in the bark, and it had been suggested that in those cases the secretion was probably functioning as a filter to protect the inner structure of the tree from the high concentration of ultra-violet rays in the very fierce sun of the East

As a chemist he ought not to conclude without referring to the development of the chemistry of the resins. The lecturer had expressed a righteous indignation at the use of the term a "de waxed" damar It was fairly clear now that the "wax" was highly polymerised resin and that its presence was also linked with the general problem as to how these gums changed in the early stages of their life, and during the period of running in solution. Problems of polymerisation entered into many matters concerning resins, and it was quite likely that sooner or later X-ray methods of investigation might give some sort of explanation

MR F HEDLEY BARRY said it was very appropriate that the lecture should come at the time of the British Industries Fair, where manufacturers gathered together and generally overhauled their consciences and considered the ways in which they could improve themselves A great deal had been heard during the last week about the importance of manufacturers knowing their materials, and knowing what was wanted The lecturer was a very interesting and valuable example of a manufacturer who had got to know his materials and what was wanted

With regard to the resins themselves, the problem was a very fascinating and a very perplexing, and very often rather a disheartening one The point which was of most interest was the difficulty of collection, the extreme difficulty of sorting and then the difficulty of getting the material to the right people in the right way. With regard to one small area to which the lecturer had referred, namely, Malaya, he remembered that when he had made his own first report to the Chief Forester, he had referred to the great difficulty of forging a close link between the home market and the forester Although the technical service was excellent, the connection between the field of operations and London was extremely defective He was very glad to learn that the lecturer had been able to add something to the link between this country and the Malayan forester.

With regard to the future of resins, synthetic resins had been mentioned. He noticed that every gum merchant referred to synthetic resin, and there was a feeling that the natural resins were up against a competition which might affect them seriously. It was not enough to collect the material; it was not enough even to get it over here. There must be a continuous and progressive policy of research on the subject for the future good of the industry. Otherwise some outside product would come in and cut it out. One could take a natural resin and, by chemically treating it, obtain a product which was more uniform, and which did away with some of the present excessive grading. This excessive grading, entailing the material passing through an enormous number of intermediate hands between the final buyer abroad and the tree itself, was one of the great troubles in connection with the industry. The most successful synthetic resins at present were blends of natural

and synthetic resins, and that suggested that chemical research on resins might lead to their becoming ingredients of another article.

MR. NOEL HEATON stated that the lecturer had devoted practically the whole of his life to the study of resins, and the Society that night had before it absolutely first-hand information about the origin and collection of resins. To have such first-hand information was of the greatest interest and importance, because in the past writers and others who had been trying to find out something about the origin of resins, and so forth, had been obliged in general to rely upon second-hand information. All resins were collected in far-away districts in the East, and in the past those interested in the subject had had to rely for their information on two sources—either residents in the country, who knew a lot about the country and the method of collection but who knew very little about resins, or people who knew a lot about resins but who had never been out to the East. That night, however, the audience had had the advantage of hearing an expert in resins who had gone out to study the matter at close quarters and who had brought the information on the matter very much up-to-date.

One point of difficulty was that of nomenclature. In the past different gums had been grouped under the same name, with the result that there had been a good deal of confusion. For instance, only last week he had been discussing the subject of varnishes with an American friend, who had told him that in the manufacture of a certain type of enamel he used East India gum. He had asked his friend: "What do you mean by that?" and he had received the reply: "We just know it in the States as East India gum." That was the sort of thing that went on all over the industry. The term "copal" was very vaguely used. It was a great pity, too, that the term "copal" had been applied to the resin from Macassar—the so called manilla copal. As he understood it from the description of the lecturer, that resin was obtained from quite a different genus of tree from the East and West African copals which were derived from the Copaifera trees. It was quite a different type of resin, and it created a great deal of confusion having these entirely different materials referred to under the same name.

The lecturer had stated that under the new Government regulations in regard to collecting copal it was laid down that a tree must not be tapped above a height of 2½ metres. Personally, he was not quite clear as to the technical reason for that. In the case of damar he gathered that the natives went quite a considerable way up the tree to tap, and that the higher they went the better quality of resin they obtained. It would be interesting to know what essential difference there was between the two types of tree which necessitated the different methods of collecting the resin. He would also like to know what was the life of a tree when it was properly tapped. The lecturer had clearly shown that improper tapping very quickly led to the death of a tree, but it would be interesting to know how long one was able to tap a tree in a properly scientific manner and still keep it alive able to deliver its quota of resin. Also, in that connection, what steps were taken, if any, in most districts to provide for the replacing of trees that were lost? Was there any systematic method of re-planting the trees?

On the subject of synthetic resins, one point he would like to make was that, whilst there were many varieties of synthetic resins, not one of them was really a synthetic resin. What he meant was as follows: When one spoke of synthetic indigo one meant the actual chemical substance which was present in the indigo produced by entirely artificial means. When one spoke of a synthetic ruby one meant the actual chemical substance—crystalline corundum—formed by artificial means. But when to-day one spoke of synthetic resin, one meant a material

which had something of the properties of resin but which was an entirely different chemical substance. It was simply a synthetic resin in the sense that it resembled it in some of its physical properties. As far as he was aware, no one had really made a synthetic resin in the same way that the tree made it. That was the point he was driving at, and possibly the lecturer would state if any investigations had been made on that point.

MR. J. CRUICKSHANK SMITH said that one point which had struck him in hearing the first part of the lecture had been the application of the word "copal." He endorsed what Mr. Noel Heaton had said in regard to the very misleading significance which the word "copal" conveyed to anyone in the industry. As he understood it, the lecturer had dealt with what were known in the trade as the soft or spirit-soluble copals only, and even in those materials there was found an extraordinary difference in physical properties. He desired to ask the lecturer to give some indication as to the probable life of the trees which produced those soft copals. It would appear, in view of the rather primitive methods of tapping, collecting, and so forth, and also in view of commercial contingencies, market prices and the like, that the position of the manufacturer who wanted to use those resins from year to year was not a very pleasant one. Owing to the likelihood of the supply running out, and apparently for other reasons, there was a strong presumption in his own mind that the day might come when there would be no more of those so-called soft copals available. That time was foreshadowed by those who were talking of synthetic productions Again, the word "synthetic" was used in an extraordinarily loose sense. Unless they could get down to some physical comparison between the so-called synthetic re-productions and the natural products, the unfortunate manufacturer would be no better off than he was before. With regard to the damars, the same line of argument applied. The Batavian, Sumatra and Penang damars could all be distinguished in terms of physical properties, and when that was done a step forward would be taken in getting better and more uniform conditions in the manufacturing world.

MR H. W. MORGAN said the lecturer had given all those interested in the industry something to digest. The lecture would be a standard reference for them for a very long time to come. They had heard that night what they had never known before. He desired to thank Mr. Suter for his extremely interesting and valuable lecture.

MR. ARTHUR T. EVANS asked the lecturer to give some further information about the origin of that hill of fossil damar in Java—what its area was, and what the yield was per ton. It was an extraordinary thing to have happened.

CAPTAIN SIR ARTHUR CLARKE K.B.E., said the lecturer had spoken about the harbour of Macassar, but had not given any idea as to its depth, or as to whether it was a tidal harbour.

MR. SUTER said it was an open sea harbour and could accommodate ships up to 10,000 tons gross.

SIR ARTHUR CLARKE said Mr. Suter had mentioned the fact of nothing having been done to develop the resin industry in Ceylon. What was the reason?

MR. SUTER said he had seen the Chief Forester, who had told him that he was very much afraid that they at the Forestry Department had become nothing but

timber merchants to the Government. Anything in the nature of minor forest products they had no time for. The natives in Ceylon did not use the resins which were indigenous to the country, and therefore they were never produced except on demand; and there was no demand for them because it took a long time to get the natives to tap in a proper way.

SIR ARTHUR CLARKE then said that the lecturer had thrown on the screen a picture of a wonderful tree of great height with a native climbing up it, and had remarked that he would not like himself to ascend it. It would not have troubled him (Sir Arthur) in the least degree to have gone up that tree. If the audience could see a small boy up the skysail yard arm of a ship, lying over on her beam ends, in a squall, trying to furl the sail, they would think nothing at all of a native climbing the tree which had been shown.

MR. SUTER, in reply, said the Chairman had asked him to say something with regard to the Central Government in Java and their influence on cultivation in the Dutch East Indies. It was very difficult indeed not to be too enthusiastic when speaking of that matter. There was some quality about the administration in the Dutch East Indies that was most admirable. He believed at the bottom of it all lay the fact that the Dutch were most systematic people. Whenever they found anything new they gave it to the scientists for full examination and investigation. They educated their people in the applied sciences necessary to cultivation in the tropics to a most extraordinary degree. They got hold of the very best men; nationality meant nothing to them. They would not support any old-fashioned machinery.

The whole of their attention was directed towards the production of these valuable copal trees. Nobody knew how long a tree would live under the present system of tapping, but the Dutch were carefully studying that matter. Copal would never die out. The Dutch had found it to be a valuable product from a fiscal point of view. They had found the necessary labour for it, and they had the necessary scientists to produce a really good article.

Mr. Heaton had mentioned the question of nomenclature. The Americans called it East India gum. That meant Macassar gum. The description of Macassar copal was very much better than manilla copal. What came out of the Philippines to-day in the shape of copal was a very inferior spirit soluble copal. This product went to America, but it was too dear owing to labour costs, and was gradually disappearing against the very much finer produce which came from Macassar. Macassar undoubtedly was the one port where all the good East Indian copals went to-day. There were not sufficient trees in Malaya to make a systematic collection, and another very grave difficulty in Malaya was that the resin would not harden. The same thing happened in Sumatra. Therefore it was no use from a commercial point of view. Mr. Heaton had asked, Why limit the height of the copal tapping? That was done because the Dutch said: "We will not kill our trees. We will give you less copal now, until we know how far we can go." As to what was the life of a tree with proper tapping, that was not known. With regard to the re-planting of trees, that matter was also in the hands of the Chief Forester.

Mr. Cruickshank Smith was under a slight misapprehension in thinking that he had only dealt with the spirit-solubles. He had only dealt with the Macassar copals. They comprised three—hard, half-hard and soft. A fact which had not been known before was that the soft and the half-hard were an identical product, with merely a slight difference in age.

He had not been able to see the hill of fossil Damar at Java. It was said to consist of literally thousands of tons of resin. A few tons were coming across now, and it would then be seen of what the resin was made. As to how that great quantity of resin got concentrated in that particular locality, it could only have got there through an earthquake destroying the forest above it.

CAPTAIN SIR ARTHUR CLARKE said it was his pleasure and duty, on behalf of the Council of the Royal Society of Arts, to thank the lecturer very cordially for his very interesting and most instructive lecture. He had listened to a great many lectures before the Society, but he had never yet heard a lecturer who had so fully grasped the *raison d'être* of all the various questions, and who had answered them so clearly as Mr. Suter. He only hoped that that wonderful hill in Java full of copal would come to fruition some day!

The vote of thanks was carried unanimously, and the meeting terminated.

CORRESPONDENCE.

RATIONAL MECHANICS.

Your reviewer admits that "the basis of Academic Mechanics is not always as sound as it might be and there is much in current text books that may be usefully criticised." To this I cordially agree, since it is my point. At the same time, he considers me as one of those awful heretics who dares to question the dicta of the "High Priests of Mechanics" (I trust that he will do me the justice to admit that I do not attack any small men), and consequently (I can only suppose) thoroughly deserving of "something with boiling oil." I must therefore thank him for having treated me with such leniency.

He suggests that I do not "understand the subject." This may, as it may not, be true; but as I have specialised on mechanics—chiefly hydromechanics—for exactly forty years, at least I think I can say that I have tried my best! *Rational Mechanics* was commenced more than ten years ago, and it has been written six times, so it has not been published in a hurry. I think I have read most of the books and papers dealing with the subject, written in English, French, Italian and Spanish, so I cannot be accused of being narrow-minded.

Unlike most, your reviewer does not confine himself to meaningless "generalities," such as saying that my views are "unsound," etc., etc. He puts his finger down, and says, "*this* is wrong"—for which I thank him; I am grateful.

The first point he specially refers to is my criticism of Glazebrook's equation "U = Fs," which, he says, we learn "is equating scalars and vectors."

Well! is it not? Work is a scalar quantity, whilst force and space are vectors. Is this disputed?

But, he says later, that I "do not appear to have met with vectorial multiplication." As a matter of fact, I have, and I *thought* I had even mentioned that A × B is not the same as B × A. The reviewer's suggestion (if I understand him correctly) is that vectors multiplied together produce a scalar. That I have *not* "met with." I have learned that they form a "quaternion"—which is essentially a vector quantity. If preferred, however, I will modify my statement and say that Glazebrook here "equates a scalar and a quaternion."

I am also reproved for saying that this paragraph is meaningless. I thought that this was fairly evident, but let me cross my " t's " and dot my " i's " a little more carefully.

Glazebrook says, page 93, " force as a *cause of motion* we have not here to consider ; it will suffice for us to define it as *rate of change of momentum* " This is splendid ; it is Glazebrook at his best !

Substituting the words, the paragraph at page 118 reads : " let the point of application of the *rate of change of momentum* be displaced, etc." How does one *displace* a rate of change of momentum ? What sort of *idea* do these words convey ? Also, on page 119, we read (changing the words, as before) : " Find the *rate of change of momentum* exerted, etc." How does one " exert " a rate of change of momentum ?

I should like to say a good deal more, but space forbids, so I can only refer to one more point. Your reviewer says that I consider that Poisson's description of the behaviour of a liquid is to be taken " as a literal fact." I certainly *do*. I think also that if the reviewer would study Theodore Schwedoff's *Recherches Expérimentales sur la cohésion des Liquides*, in the Société Française de Physique for 1889, he would see experimental proof of what I have said. It certainly satisfied me, and it is, in any case, *extraordinarily interesting*.

Finally, if mechanics is to be anything more than a mathematical plaything, it should enable us to calculate the resistance of bodies moving in fluids. Now, what can the academic mechanics enable us to calculate ? One can only sadly reply, " nothing." Lamb's monumental work explains very fully what " perfect " - mathematically-trained - fluids would do. *Real* fluids, however, are ferae naturae, and do not behave "as they ought to." Following Newton's teaching - Newton, that intellectual " wonder of humanity " I have shown that it is not difficult to calculate these resistances ; and I suppose that what one fool can do, another can.

R. DE VILLAMIL.

NOTES ON BOOKS.

FRENCH SIXTEENTH CENTURY PRINTING. By A. F. Johnson. London : Ernest Benn, Ltd. 15s.

This book traces the development of what may be termed the renaissance style in French printing from its birth under the influence of Italy in the early 16th century, up to the effective entrance of engraving upon the field of book-decoration about 1596.

The sixteenth century is seen to open with types of the Gothic order in full and vigorous possession of French typography. Up to 1500 the humanist influence of Italy had as yet scarcely been felt in France, and it was not until the Italian classical revival had captured first the imagination of such scholars as, for instance, Robert Estienne and Geofroy Tory, and inspired them with the idea of becoming, as publishers and printers, the typographical god-parents of the new learning, that the roman and italic types commenced their vogue as the natural interpreters of its spirit.

Once started, the progress was rapid, nor was it confined to printing alone, in the sense of the utilisation, in book-design, of existing types. The art of type-design and type-cutting in France also took fresh force with its new direction. At first the French craftsmen frankly drew for their inspiration direct upon Italian work such as the *Polifilo* and the Aldine classics, but it was not for long. The French genius quickly produced original models, showing, it is true, a natural kinship with

the Italian, but yet definitely native and significant. Here rise the "Garamond" romans of Colines and Estienne, of Augereau, and of Claude Garamont himself, while there is an equal, and fully as interesting, parallel development of the cursive types, ranging from the more formal and monumental "faces" such as those of Colines and Denys Janot to the more delicate and condensed Aldine character.

Though it is true that, in individual hands and in a limited channel, the Gothic did actually survive until the close of the century, it may be said to have passed out of general use by 1530.

The middle of the century finds the purely native romans of the so-called Garamond genus widely and securely established; to such a degree, indeed, that they remained in full use into the opening of the 18th century both in France, the Netherlands and elsewhere, and were destined to dominate the roman letter in France for an even longer period.

The influence of great men is always difficult to determine, since they are in general too fully occupied in the living of life and the fulfilment of the bent of their genius to be narrowly concerned in leaving memorials, signed, dated and authenticated, behind them. Nor, perhaps (at least to the general reader), is exactitude in this direction of great importance, though it certainly gives difficulty to the historian of printing.

Mr. Johnson necessarily, however, surveys briefly the many-facetted work of Geofroy Tory, to whom, under the dual spell of ignorance and enthusiasm, there has been a tendency to attribute a disproportionate share of the work of this very active period. Tory—scholar, publisher, artist and *homme d'esprit* as he surely was—did not himself print much, and it is perhaps to his stimulating influence upon the work of others, both printers and type-designers, together with his initiation of the lighter form of book decoration, designed to harmonise in "colour" with the new types it accompanied, that one must look for his greatest, if least definitely mensurable, contribution to his time.

That the name of Claude Garamond (or Garamont as he seems to have styled himself) has come to be applied to many of the roman founts of his period is not perhaps unnatural, upon the results of a first and cursory investigation, but the light of more recent critical research (see Mr. Johnson's work in *The Fleuron*, Vol. VI) has shown that much of such attribution (at least in the direct sense) is unfounded. As Mr. Stanley Morison has remarked, it is somewhat of an irony that, of the many modern "Garamond" revivals, the one which approaches nearest to the spirit of Garamont's great letter is the only one *not* called by his name. This is the "Granjon" of the Linotype Company.

Robert Granjon is a name which, with Jean de Tournes, stands for the greatest force in the Lyonnese typography of the period under review. Hitherto it has been Paris that has been tacitly referred to, but the significance of Lyons was, in its own field, fully as great, and especially in the French development of the Italic. The influence of the Lyons printers passed, as did Granjon's types and "fleurons," far beyond the borders of France, modifying and deeply affecting the work of the Netherlands and England also.

In matters of decoration, the work of Tory has already been touched upon. The light-coloured, graceful and "lively" arabesques associated with his name and with those of Tournes and others, and the combinable "flowers" of Granjon, expressing their motives in black upon an open ground, were in natural harmony both with the colour-weight of the new faces, roman and italic, and with the free spirit of the renaissance of which they were the outcome. Hence their displacement of the heavier, black-grounded or *criblé* decoration, characteristic of and natural to the strong, austere gothic pages, was inevitable and immediate. The 17th century

ushers in a new and significant development in French book-decoration—the use of engraved work upon title pages, and in initials and page-embellishments. At this point Mr. Johnson fittingly closes his essay.

The publishers rightly style this work an essay rather than a book. The scope is wide, the treatment discursive, yet lucid, giving in its skilful handling no obtrusive sense of the wide knowledge and the labour upon which it is based. It seems calculated rather to stimulate interest and give direction to further and more detailed study of the subject than to provide detail though, in reality, much detail is there. In this connection, a bibliography, however slight, would have been a welcome addition, since the opportunities for first-hand research amongst originals are denied to the majority of readers

The 50 plates cover a wide range, but it is difficult to see why they must be placed at the end of the book, divorced, not only from the relevant passages in the text, but even, by the method of arrangement, from their own descriptive matter. In fact, the suggestion is hard to avoid that the plates were chosen not so much to illustrate the essay as for each to stand alone, the two linked more by a somewhat cool, sisterly affection, bordering on mutual indifference, rather than by any close conjugal bond. This would seem borne out by the fact that the text makes but three specific references to the plates and, of these, one is incorrect.

No book whose subject is typographical can fail itself to be examined from the typographical point of view, however illogical it may be to do so. It would seem part of the eternal fitness of things that books upon matters of printing should be produced in a manner at least decent, typographically speaking. In this and in respect of its paper, Mr. Johnson's very pleasant volume is unfortunate It is printed upon a Matt "Art" paper, of all papers the least defensible, nor can it be pleaded that this is technically unavoidable, for "line" reproductions such as are here presented can (as has been amply demonstrated) be printed readily upon "Antique" papers. Compare, for example, that fifth number of *The Fleuron* to which Mr. Johnson refers on p 18 In the present instance, not only does the "Art" paper lend a mean and characterless appearance to the pages, while it robs the volume of durability, but it emphasises the unhappy selection of the type used. Caslon "Old Face" is never a strong type and is at its best without space between the lines. When, as in this book, it is used in Pica size, "leaded" to allow the eye to "carry" so wide a line, and is, in addition, very loose-set, the effect becomes acutely miserable. Mr. Johnson's skill and labour, alike, are worthy of a better setting. D.W.L.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock.

APRIL 24. LYNTON FLETCHER, B.A. (of the British Broadcasting Corporation), "Recent Developments in Educational Broadcasting." PROFESSOR T. PERCY NUNN, M.A., D.Sc., Litt.D., will preside.

MAY 1.—P. MORLEY HORDER, F.S.A., "Architectural Models." THE RIGHT HON. LORD ASKWITH, K.C.B., K.C., D.C.L., will preside.

MAY 8.—CHARLES J. FFOULKES, O.B.E., F.S.A. (Curator of the Armouries, Tower of London), "War and the Arts." PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, will preside.

MAY 15.—ROBERT BURRELL, Barrister-at-Law, "The Reform of the British Patent System."

INDIAN SECTION.

Friday afternoons, at 4.30 o'clock.

MAY 10.—P. JOHNSTON-SAINT, M.A., F.R.S.E., Secretary of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." (Sir George Birdwood Memorial Lecture.) SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, will preside.

The lecture will be illustrated by lantern slides.

ALDRED LECTURES.

Monday evenings, at 8 o'clock.

SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of th School of Oriental Studies, University of London, "Nomadic movements in Asia.' Four Lectures: April 22, 29, and May 6, 13.

LECTURE I.—The Arabs. The Arabian Peninsula. Life in town and desert. Primitive religion of the Arabs. The rise of the Prophet Muhammad. Dissension and warfare among the Arabs. Unification of the Arabs. Advance of Arab arms into Syria and Persia. Triumph of Muslim armies East, North, and West.

LECTURE II.—The Turks. The Mongolian desert. The rise of the Turks. The Great Wall of China. The first Westward movement of the Turks.

LECTURE III.—The Seljuks. The infiltration of the Turks into Transoxania and Khurasan. The rise of independent Turks in Islam. Mahmud of Ghazna. The rise of the Seljuks.

LECTURE IV.—The Mongols. The rise of Chingiz Khan. His career of conquest. The invasion of Europe by the Mongols. The invasion of Persia by Hulagu Khan. The sack of Baghdad.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 22..Architects, Royal Institute of British. 9, Conduit Street, W. 8 p.m. Mr. John Begg, "The Work of George Wittet."

Asiatic Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Dr. W. Filchner, "My Central Asian Expedition, 1925-1928" (Joint Meeting with the Central Asian Society.)

Automobile Engineers, Institution of, at the University, Sheffield 7 p.m. Dr. H. J. Gough, "Recent Developments in the Study of the Fatigue of Materials.

Geographical Society, at the Polytechnic Theatre, Regent Street, W. 8.30 p.m. Mr. G. M. Dyott, "The Search for Colonel Fawcett."

At Lowther Lodge, Kensington Gore, S.W. 4 p.m. Miss E. G. R. Taylor, "Roger Barlow: An Early XVIth Century Geographer."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6.30 p.m. Annual Meeting. Informal Discussion on "The Engineer as a Salesman."

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Dr. Alfred Schofield, "Humanity."

TUESDAY, APRIL 23..Automobile Engineers, Institution of, at the Engineering and Scientific Club, Wolverhampton. 7.30 p.m. Mr. H. W. Pitt, "Central Lubrication of Chassis Bearings."

Chadwick Public Lecture, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8 p.m. Mr. C. F. Stromeyer, "What Health and Civilization owe to Engineering."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

WEDNESDAY, APRIL 24..British Science Guild, at the Mansion House, E.C. 4.30 p.m. (1) Sir Frederick Keeble, "Fertilisers from the Air. (2) Mr. A. B. Shearer, Rayon "(Artificial Silk)" (3) Mr. F. H. Carr, "Synthetic Drugs."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m.

Eugenics Society, at Burlington House, W. 5.15 p.m. Dr. C. J. Bond, "Hemilateral Asymmetry in Animals and Man and its Relation to Cross-Breeding."

Geological Society, Burlington House, W. 5.30 p.m. "The Geology of part of North-Western Rhodesia," by R. Murray-Hughes, with Petrographical Notes by A. A. Fitch."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 5 p.m.

THURSDAY, APRIL 25..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Squadron-Leader C. L. Scott, "By Flying-Boat to India."

Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Sir Harold Hartley, The Theodore W. Richards Memorial Lecture.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Dr. G. C. Simpson, "Lightning" (Kelvin Lecture.)

University of London, at Bedford College for Women, Regent's Park, N.W. 3 p.m. Prof. Mackie, "The Study of Scottish History."

FRIDAY, APRIL 26..Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. W. Holmes, "Load-levelling Relays and their Application in connection with Future Metering Problems."

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. Discussion on the teaching of Geometrical Optics. Papers by Mr. T. Smith, Dr. G. F. C. Searle, Instructor-Captain T. Y. Baker, Dr. J. W. French, Mr. W. Ewart Williams, Mr. C. G. Vernon, Mr. H. H. Emsley, Mr. C. W. Hansel, Mr. H. Tunley, Mr. L. Moore. Mr. Conrad Beck, My V. T. Saunders, and Dr. C. V. Drysdale.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. R. W. Chambers, "English Civilisation from Alfred to Harold, 900-1066."

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FRIDAY, APRIL 26th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 29th, at 8 p.m. (Aldred Lecture.) SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic Movements in Asia." (Lecture II.)

WEDNESDAY, MAY 1st, at 8 p.m. (Ordinary Meeting.) P. MORLEY HORDER, F.S.A., "Architectural Models." THE RIGHT HON. LORD ASKWITH, K.C.B., K.C., D.C.L., will preside.

INDIAN SECTION COMMITTEE.

The list of members of the Indian Section Committee is as follows:

Sir Reginald A. Mant, K.C.I.E., C.S.I. (Chairman).
Sir George Sutton, Bt. (Chairman of the Council).
Sir Charles H. Armstrong.
Lord Askwith, K.C.B., K.C., D.C.L.
Sir Charles S. Bayley, G.C.I.E., K.C.S.I.
Sir George S. Barnes, K.C.B., K.C.S.I.
Lt.-Col. Sir Charles H. Bedford, LL.D., D.Sc., M.D.
Sir M. M. Bhownaggree, K.C.S.I.
Sir Atul C. Chatterjee, K.C.I.E.
Sir Valentine Chirol.
William Coldstream, I.C.S. (retired).
Laurence Currie, J.P.
Sir Edward A. Gait, K.C.S.I., C.I.E.
Col. Arthur Hills Gleadowe-Newcomen, C.I.E., V.D.
Sir Claude H. A. Hill, K.C.S.I., C.I.E.
Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
Rt. Hon. Viscount Inchcape, G.C.M.G., K.C.S.I., K.C.I.E.
Field-Marshal Sir Claud W. Jacob, K.C.B., K.C.M.G.
Sir Louis James Kershaw, K.C.S.I., C.I.E.

Sir Henry Ledgard.
H. A. F. Lindsay, C.B.E., I.C.S.
Sir Charles C. McLeod, Bt.
Col. Sir A. Henry MacMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.
Thomas McMorran.
Sir John Ontario Miller, K.C.S.I.
Brig.-Gen. Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G.
Major H. Blake Taylor, C.B.E.
Lt.-Col. Sir Richard C. Temple, Bt., C.B., C.I.E
Carmichael Thomas.
J. A. Voelcker, Ph.D., F.I.C.
Sir N. N. Wadia, K.B.E., C.I.E.
Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O.
Col. Sir Charles E. Yate, Bt., C.S.I., C.M.G.
W. Perry, B.A. (Secretary).

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 17th, 1929. PROFESSOR LEONARD ERSKINE HILL, M.B., F.R.S., Director of the Department of Applied Physiology, Medical Research Council, in the Chair.

A paper on " The Properties and Applications of ' Vita ' Glass " was read by MR. F. E. LAMPLOUGH, M.A., late Fellow of Trinity College, Cambridge. The paper and discussion will be published in the *Journal* dated June 21st.

ALDRED LECTURES.

MONDAY, APRIL 22nd, 1929. LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., in the Chair.

SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, delivered the first of his course of four lectures on " Nomadic Movements in Asia." The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, MARCH 8TH, 1929.

SIR EDWARD D. MACLAGAN, K.C.S.I., K.C.I.E., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Mr. Moreland was a leading authority on the subject of Indian agriculture and the Indian peasant. For a long time Mr. Moreland had been in the Indian Civil Service, and had served not

in one of the outlying Provinces of India, but in what was in many respects the most representative and the most typical part of India, namely, the United Provinces. During his time there Mr. Moreland had spent twelve years or so in charge of the Department which looked after the development of agriculture among the peasants in those Provinces. He had, therefore, had many opportunities of making himself acquainted with the Indian peasant. Those who knew Mr. Moreland might rest assured that he had made the very best use possible of those opportunities. Since he retired, about fifteen years ago, Mr. Moreland had devoted the greater part of his time to a very arduous and careful study of the economic history of India, especially in the sixteenth and seventeenth centuries. Those who had read his books about India would recognise what an enormous amount of work he had put into his investigations, and what a great authority he was on the economic and agricultural aspects of Indian history. He understood that Mr. Moreland had prepared a further book, which would appear shortly, on the agrarian systems of Moslem India. Those who were interested would find in that book the very last word to be said on that very fascinating but somewhat elusive and abstruse subject. The audience, then, had before them a lecturer who was the best authority on the peasants of India and on the history which dealt with them. Therefore, in view of that combination of knowledge, they would appreciate that they had before them something very like an oracle.

The following Paper was then read :—

THE INDIAN PEASANT IN HISTORY.

An Introduction to the Linlithgow Report

By W. H. Moreland, C.S.I., C.I.E.,

Formerly Director of Land Records and Agriculture, United Provinces.

What I have to say this afternoon arises directly out of the report of the Royal Commission on Indian agriculture ; but I do not intend to summarise that rather formidable document, still less to criticise it in detail.

As for a summary, the report presents more than 600 important conclusions ; and any attempt to compress them into half an hour or so would necessarily be unfruitful. As for detailed criticism, my view is that at the present juncture it is likely to do more harm than good. The outstanding feature of the report is its insistence on the need for a co-ordinated policy of rural reconstruction, a mass attack on the causes of poverty, waste, and inefficiency. All the specific conclusions, important as they are, are by comparison matters of detail ; and those who accept, as I unreservedly accept, this fundamental recommendation, will do more good by uniting to press for early and effective action, than by insisting on their individual views on this topic or on that.

The criticisms that have been appearing in India during the last few months show what I mean. You find, as a rule, a sentence, or even an entire paragraph, testifying to the excellence of the Report as a whole ; and the rest of the article consists of vigorous destructive criticism of some particular set of

recommendations. An excellent report, says one critic, but it's all wrong about the cattle. An admirable report, says another, but it's all wrong about the colleges. Others attack the proposed scheme of finance, or the organisation for research, or any one of a dozen different topics, each of them important, but all of them subordinate to the main issue; and in point of fact we have a revival of the time-honoured Asiatic practice of stoning an offender to death. Two or three stones may not hurt very much, but in the end the victim succumbs to the multitude of missiles. I confess that, like other critics, I have a few stones ready to my hand, but I have not come here to display my marksmanship in public. It is much better, I suggest, to leave the necessary detailed criticism to the keen brains of the administrators who have to translate the new policy into fact; the best service we others can do is to concentrate attention on the need for prompt and effective action, instead of providing excuses for the people who want to do nothing, or the more dangerous enemies who want to do nothing but talk.

The question to which I wish to invite your attention to-day is one with which the Commission was not required to deal. Why was this Commission wanted at all? How has this urgent need for rural reconstruction arisen? Why is it necessary to mobilise all the forces of India in order to get the peasants to do what you and I would only be too glad to do if we had the chance—make a little more money, and live rather better than we do at present? That is not a normal state of affairs. You will not find it, for instance, in other parts of the Empire; and I well remember how the difference struck me when I paid a visit to Australia about thirty years ago. In India I had left the departments trying, not very successfully, to hustle the agriculturists; in Australia I found the agriculturists hustling the departments, and with a substantial measure of success. What are the causes of this difference in attitude?

An enquiry of this kind is worth making. At the beginning of a long and arduous campaign, such as the Commission urges, it is well to learn all you can about the enemy—not merely the positions he occupies at the moment, but how he has reached those positions, how they are connected with his base, and what hidden reserves, or hidden weaknesses, lie behind. It may fairly be said that most of the mistakes we made in India a hundred years or so ago were due to our ignorance of what had gone before; and now, at the outset of this new enterprise, it is well to try and eliminate that particular cause of inefficiency.

If you look through the literature of the last century you will find that various theories, or guesses, have been put forward to account for the distinctive mental attitude of Indian peasants in the mass. The oldest, and simplest, of these theories is that the peasant was made that way; but the world has passed the stage where such theories of special creation had to be taken seriously, and it is enough to point out that this view is contradicted by the facts. Indian

peasants, as I have known them, are neither placid nor contented. They grumble at least as much as we do, and, like the rest of us, they have their ideals of a better life; but they have also what it is the fashion just now to call an inhibition, which prevents those ideals from being translated effectively into action, and the question is how this inhibition has come into existence.

A common theory is that it is all the fault of the climate. The answer to that theory is that the climates of India are of all sorts. Every authority, from the *Imperial Gazetteer* down to the latest sixpenny handbook, insists on the diversity; and for my part I find it hard to understand how all these different climates can have produced a uniform effect. Let us remember, too, that our predecessors were accustomed to explain differences inside India by these same differences of climate. When, for instance, Akbar's historiographer royal wanted to explain why there was so much more sedition in Bengal than in Agra, he found a simple and convincing explanation in the peculiarities of the Bengal climate, which notoriously bred sedition. I do not say he was right, either as to the fact or its explanation; but I think his reasoning was rather less unscientific than the theory that a uniform result can be attributed to such a heterogeneous entity as the Indian climate. We may agree that over large portions of India the natural conditions are unfavourable to continuous effort. That fact undoubtedly increases the difficulty of rural reconstruction, but it cannot by itself explain why reconstruction is required.

Another theory is that the peculiarities of the peasant's mentality are entirely the result of his diet. Of course, Buckle is out of fashion nowadays; but some recent scientific work in India suggests that there may possibly be something in this view. In some parts of the country, particularly the rice-eating tracts, it is quite possible for a man to eat too much and yet starve; he may get more calories of energy than he needs, and yet get too little protein to maintain his body in reasonable vigour. That kind of deficiency would go some way towards explaining the phenomena we are considering; but it would not help us in the North, where the ordinary diet of cereals and pulses is well-balanced, and will keep a man in vigorous health, if only he gets enough of it. If peasants in the North are underfed, as some of them are, it is part of the problem of poverty, not its primary cause; they eat as much as they can get, and what is wanted is to convince them that they can get more, if they set to work in the right way.

It seems to me, then, that these physical and physiological theories do not carry us far. As against them, I suggest that the main cause of the distinctive mentality of Indian peasants is to be found in the human environment, in the régime to which they have been subjected during the historical period. A survey of that régime shows that it was precisely of the kind which an expert psychologist might prescribe in order to produce the mentality which now exists. It enforced and stereotyped a very low standard of living; it penalised all enterprise; it denied all reward to the peasants; and it offered rewards

of almost unbounded magnitude to the men who could exploit the peasants with success. Let us see how this régime operated through the centuries.

We first meet the Indian peasant in the Dharma, the Sacred Law of Hinduism. His position there was simple. We read little or nothing about rights; but we find that the peasant's duty was twofold—to cultivate the land, and to pay a share of the produce to the King. That fact is important. Right into the nineteenth century the idea persisted that cultivation was a duty to God and to the State, not a right to which the peasant was entitled; and probably the old idea still lingers in some of the backward parts of the country.

We have no records to tell us how this Sacred Law worked in practice, but obviously the essential question was the amount of the share claimed by the King as his revenue. If it amounted to a rackrent, leaving the peasant nothing to hope for, we have substantially the régime I have described; if it left the peasant a reasonable reward for effort, the conditions necessary for progress may have existed in the Hindu period. I do not know which alternative is true for this period as a whole, but there are signs that the King's share tended to increase as time went on, and that it came, at any rate, very near the danger point.

In the earliest texts the share which might be claimed by the King varies from a sixth to a tenth or a twelfth. This is quite a reasonable proportion, though higher than is now considered proper. Presently, however, we find the smaller figures disappear, and the former maximum becomes the standard. Then we read of "what is called a sixth;" and a commentator explains, in language which almost recalls the methods of Somerset House, that the phrase "a sixth" includes a third. We may take it then that Hindu kings eventually claimed about a third of the peasants' produce; and we know that until quite recently the claim in Hindu Rajputana ranged from a third to a half.

It is impossible to speak with precision as to what constituted a rackrent in those early days, but it is safe to say that a third was dangerously near, and that a half left the peasant practically nothing but a bare subsistence. It is quite possible, then, that rackrenting prevailed in Hindu times, extensively if not universally, but there is too little evidence to justify a conclusion; all that can be said is that it is dangerous to take the figures given by text-writers such as Manu as an accurate presentation of the practice of the later period.

We are on firmer ground when we come to the twelfth and thirteenth centuries when the period of Moslem rule began. The religious law of the Moslem conquerors recognised, if it did not formally prescribe, a régime of rackrenting. Under that law the conqueror had a perfectly free hand, and it was open to him to dispossess unbelievers, and distribute their land among his Moslem followers; but if he left the unbelievers in possession, as was done in India, the idea was that the profits of agriculture should enure to Moslems and not to Hindus. The conqueror claimed a share of the produce, just as Hindu kings claimed a share, but there was no arithmetical limitation, such as is

found in Hindu law, and may have been effective in Hindu practice. The only limit recognised by Moslem jurists was the risk of driving the people off the land; and in practice that means rackrenting. So long as the peasants did not rebel or abscond, it was lawful to take all they could be made to pay.

This legal theory is by no means unimportant. It is true that in India many Moslem rulers ignored Islamic law in their administration; but any Moslem who wanted to rackrent could do so with a clear conscience, a thing which counts in practice. Further, there was no possibility of religious opposition to rackrenting, such as occurred in some parts of Europe. In India the religion of the rulers was on the rackrenter's side. Practice, however, is more important than theory, and the practical question is, how Indian peasants, in fact, fared under Moslem rule.

Here the authorities we possess require rather careful handling. We have glowing accounts of the work of a few agrarian reformers, great Kings like Sher Shah or Akbar, sagacious Ministers like Todar Mal in the North, or Murshid Quli in the Deccan, men who tried to treat the peasants equitably, and confine the claims on them within reasonable limits. The work of these men naturally receives prominence in modern textbooks; and the ordinary reader is apt to conclude that care for the peasant was a feature of the period taken as a whole. This was certainly not the case. Measured either by time or by area, these prominent events are mere episodes; when you reckon them up they account altogether for perhaps less than fifty years out of the six centuries of Moslem rule; and for the great bulk of the period the fortunes of the peasants were in the hands, not of great kings or sagacious ministers, but of a multitude of intermediaries, each man intent only on filling his pockets, and precluded, as I shall show, from doing anything in the way of permanent improvement. These intermediaries are the key to the agrarian history of the period; they were of various types, but the two figures which stand out decisively are the revenue-assignee and the revenue-farmer.

An assignee was usually one of the officers of the kingdom, and as such entitled to a salary defined in cash; but instead of being paid from the treasury, he was given what was called a *jagir*, that is to say, a district which was estimated to yield the amount of his salary as land-revenue; and it was his business to assess and collect the revenue from the peasants so as to obtain the promised salary, while it was his obvious interest to make the assignment yield more.

It is quite safe to say that the *jagir*, or assignment, was the most important agrarian institution of the Moslem period in India. You meet it all over the North, and almost all over the Deccan and Gujarat. One or two rulers tried to do without it for a time, but it always came back; and ordinarily more than three-quarters of the country was in the hands of assignees, who must thus be regarded as the peasants' real masters. What was the attitude of these masters?

To begin with, habits of luxury and extravagance prevailed among the ruling classes almost throughout the Moslem period. There was therefore constant and urgent need of money, which the peasants had to find. At the same time, there was an intense desire to accumulate large fortunes, and these, too, had to be provided by the peasants. To outshine your fellows in your lifetime by extravagant display; to outshine them after death by your hoards of cash and jewels; these were the chief social ambitions of the class from which the assignees were drawn.

In theory, two courses were open for their realisation. A man might set to work to develop his assignment, investing capital, encouraging the peasants to improve their production, waiting some little time for the result, and eventually enjoying a steadily increasing income drawn from the increasing prosperity of the peasants. That course was definitely ruled out by uncertainty of tenure. An assignee might be shifted every year, or he might be able to retain his holding for some time; but he never knew from day to day what his fate might be. The struggle for productive assignments was very keen; to invest capital, or leave resources in the peasants' pockets, would have merely been to invite other claimants to come forward. The only prudent course was to squeeze your assignment dry, and then set to work to get transferred to one which still held a little money. That was the ordinary state of affairs throughout the Moslem period.

Now let us look at the other figure, the revenue-farmer. Perhaps you will say that there was not much room for him, with so much of the country held in assignment; but assignees commonly farmed out the revenue to which they were entitled, so that farmers were numerous. Again, when land was reserved for the royal treasury, the officials often either let it in farm, or took the farm themselves; in either case, there was someone besides the treasury looking for an immediate profit. The characteristic of all these farms was their short duration. A year was the ordinary period; and three years is the longest I have read of up to the eighteenth century. Obviously, then, no farmer could dream of carrying out a policy of development; like the assignee, the farmer was bound by the conditions of his tenure to squeeze the country dry.

Again, it must be remembered that competition for these revenue-farms was usually keen. Farming was a regular business or profession; and success in the face of competition depended on ability, first to obtain a district with some money in it, next to extract that money out of it, and lastly to keep other competitors away until the mine was nearly worked out. All this involved the existence of some very undesirable classes, spies and informers, touts to push the farmer's interests, and "wreckers," as they were aptly called, to discredit his competitors. The final result was a large number of experts, who depended for their livelihood on gathering in every penny that the country could be made to yield. In essentials, then, there was little to choose between farmer and assignee.

In one respect, however, there was an important difference. The farmer's person was pledged for the fulfilment of his contract, and the penalties for failure were drastic. There are records of defaulters being flayed; but this measure was, I think, quite exceptional. Something more gradual was preferred, and an ordinary method was to keep the defaulter in prison, and flog him or torture him with rack and pincers, two or three times a week, until he either found the money or died of his wounds. If then farmers stripped the country clean, they often had a very strong motive for doing so; it was flog, or be flogged.

Ordinarily, then, the peasants' masters must have had the will to rackrent, they also had the power. You will remember that production and payment of revenue constituted a duty to the State; and flogging was a prescribed penalty for peasants who failed in that duty. Further, the practice was to sell the wives and children of defaulting peasants as slaves. With these powers at their disposal, assignees and farmers were in a strong position: peasants could rebel, or abscond, but short of such action they were helpless.

Perhaps the best illustration of the position, as it had developed in what some people like to think of as the golden age of Shahjahan, is the argument which François Bernier put into the mouths of the assignees and farmers, with some of whom he was on familiar terms. Why, he makes them ask, "should the neglected state of this land create uneasiness in our minds? And why should we expend our own money and time to render it fruitful? We may be deprived of it in a single moment, and our exertions would benefit neither ourselves nor our children. Let us draw from the soil all the money we can, though the peasant should starve or abscond, and we should leave it, when commanded to quit, a dreary wilderness." To that argument there was no effective answer.

Such, in bare outline, was the régime under which the mass of the peasants lived and worked in Moslem India. The question naturally arises whether things were better in those parts of the country where Moslems did not rule. Here precise information is wanting; but there are signs that in the north and centre of India things were sometimes rather better in the Hindu States, because peasants sometimes sought a refuge there when oppression became intolerable. In the South, on the other hand, we know that over large areas farming prevailed in the worst possible form, the farms being auctioned yearly; and with that system it seems to me that rackrenting must have been inevitable.

One other factor in the situation must be noticed. The idea that the farmer or assignee should be content with a specified share of the peasant's produce did not wholly disappear. The recognised share ranged usually between a third and a half, that is to say, at or beyond the danger-point; but in addition to the basic claim, there were traditional supplementary demands, which in the aggregate made a substantial addition to the burden. Everybody concerned in the assessment or collection of the revenue wanted something for himself,

"the tenth and the half-tenth," "the one per cent." and the "two per cent," the fee for measuring the land, the fee for estimating the produce, and all the other traditional items which we hear of only in the records of unsuccessful attempts to prohibit them or regulate their amount; and these supplementary exactions must have operated to produce a clean sweep of everything the peasants were known to have in their possession. The régime under which the bulk of the Indian peasants lived during six centuries may thus be described briefly as rackrenting, under the whip.

The essential features of this régime may be summarised as follows: In the first place, no constructive policy of development was possible. The idea of development was indeed present, at any rate, from the fourteenth century onwards. Ghiyasuddin Tughlaq, the old soldier-king, held that governors and collectors could make or mar the kingdom; and he insisted on their duty to strive for steady extension of cultivation, with a gradual rise in revenue, not for such an immediate enhancement as should ruin the country. His doctrine, however, had no effective force, and his brilliant but eccentric son devastated a large area merely by the severity of his assessments, which drove the peasants into rebellion. In later periods, also, we meet similar ideas from time to time, but they scarcely ever came to fruition; the needs of the moment were usually far too pressing for anyone to think about the future.

In the second place, there was no chance of a rise in the peasants' standard of living. No peasant could dare to be seen spending money, for that would mean increased demands by his masters. It was much better to bury money than to spend it.

In the third place, the life of a peasant had, at the best, very few attractions. It was much better to be a parasite than a producer; the parasite carried the whip, the producer must expect to feel it.

The essence of the whole agrarian system was thus a barren struggle to divide, instead of a concerted effort to increase, the produce of the country. The peasant tried, sometimes successfully, to hide his gains; his masters tried to discover and appropriate them. It seems to me to be beyond dispute that such a régime, prolonged through the centuries, would of itself suffice to produce the type of peasant which the earliest British administrators found in India, not much more than a century ago.

The history of the short intervening period is too well known to require recapitulation; but it may be well to recall that for some time English administrators tried to work the system which they found in operation, and that the change was gradual. The whip was very soon discarded, but the nineteenth century was well advanced before the practice of rackrenting was formally condemned; it has not yet entirely disappeared, but for some time now the bulk of the peasants have been in a position to retain a portion of any profits they may make, and to spend them without the old anxiety as to the result. That is the central fact of the agrarian situation of to-day. Just three centuries

ago, some English merchants in India wrote that what was wanted for the recovery of the country was to "give the people leave to lift up their heads in one year's vacancy from oppression." It would not be true to claim that oppression no longer exists, but it may fairly be said that now, for the first time for six centuries, and possibly for sixteen, the peasants have been given a chance of lifting up their heads.

It has seemed to me worth while to bring this view forward at the present juncture. The Indian administration, in the midst of its heavy preoccupations, has been called on to undertake a new and arduous enterprise; let us try to concentrate attention on the fact that the enterprise, though arduous, is by no means desperate. As I read the story of the past, it carries a message of encouragement and hope for the future. Recall for a moment the various theories I have enumerated as to the causes of the present situation. If we held that the peasants' apathy is the result of a special creation, we should have to admit that the only logical remedy is to scrap the peasants, and create new ones in their place. If we held that the situation is due wholly to the climate, logically we should have to set to work to juggle with the ecliptic, in an attempt to shift the antarctic ice-cap. Even if we held that diet is the primary factor, we should have to begin by attempting to change the thing which all social reformers know to be the most difficult to change from above.

On the view I have put forward, the task before the Indian administration is less arduous, though I do not say that it is easy or simple. It has to deal with the residual effects of causes which have now almost ceased to operate. They operated in any case long enough to produce a situation of the greatest difficulty, an ever thickening crust of apathy and hopelessness, formed over the entire country; but the crust has now ceased to thicken, and in places, particularly in the Punjab, it is obviously wearing thin. There is now scope for work which would have been hopeless half a century ago, and would probably have been premature even when Lord Curzon initiated the policy of which the Linlithgow Report is the direct outcome. There is now a reasonable hope that a concerted and sustained effort, such as the Report advises, may break up the crust once for all, may liberate the stores of energy which are now dormant, and may convince the peasants in the mass that it is worth their while to strive for the ideals they have never wholly lost. That, as it seems to me, is the message of the past.

DISCUSSION.

The Chairman said the meeting had heard a very interesting explanation of the root difficulty which Mr. Moreland had mentioned at the beginning of his paper, namely, what one might call the passive character of the Indian peasant. Personally, he had to confess with shame that he had always been an adherent of the first of the theories which the lecturer had mentioned, and on which he had poured so much scorn—the theory that the Indian peasant was built that way.

He was reminded of an incident which had occurred to him in India when he was visited in his district by the leading agriculturist in India of that day. They had both gone round the Public Gardens and had been very much impressed with the immense production of the vegetables, flowers and trees in those gardens. He had been very anxious to acquire some information, and he had asked the agriculturist if he could tell him why the soil at that particular place was so fertile, and the great man had replied, " Well, it is fertile because of its fertility." That was very much the sort of view which one was apt to take of the Indian peasant, namely, that he was passive because of his passivity. Other theories had been put forward in the course of the paper, especially the lecturer's own particular view, and it would be interesting to hear what remarks would be made upon it.

SIR HENRY S. LAWRENCE, K.C.S.I., said it was easy to praise a Paper which was based on original research and historical learning of a very high order. It was difficult and less gracious to criticise it, but he would essay that difficult and less gracious task

The paper had been written by a scholar for scholars, and assumed in its hearers and readers both knowledge of the subject and goodwill. In the distinguished and very select audience present both those qualities were assured ; but, elsewhere, certain parts would be misunderstood by the ignorant, and misrepresented by the malevolent.

He referred first to Mr. Moreland's statement that the practice of rack-renting had not yet entirely disappeared, and that oppression still existed. Mr. Moreland perhaps distinguished rents paid to landlords, from taxation paid to the State, but there were people who were apt to confound the two ideas, and who would be glad to claim Mr. Moreland's support for their attacks on the land revenue system of India. Perhaps in his reply Mr. Moreland would make his position clearer. Mr. Moreland believed that the history of the last century was " too well known to require recapitulation." His own experience was quite different, and he held that no period of history was less understood in this country, or more seriously misrepresented. There were political parties in this country who advocated the nationalisation of land. Did they recognise that land had been nationalised in India throughout the ages ? It was true that under the personal rule formerly prevailing it was the property of the Hindu King or Mughal Emperor, but it was now the property of the State, and since the Governments of India had assumed that charge, the lot of the peasant had been improved, and the percentage of his produce taken in taxation had been continuously reduced. And yet the very men who anathematised the principle of private ownership of land in England supported movements in India the object of which was to restrict the rights of the State over land. Close study of those systems might indeed reveal to our Statesmen at home how to confer on the people the magic right of property, and to combine with it the reservation to the State of the communal right to increments of value.

Mr. Moreland was a severe critic of the Moslem rulers of Northern India. He held that care for the peasant was not a feature of their period, and ascribed that defect in part to their religious law. The reference to religious law might well have been omitted, for history in those centuries recorded no instance of the application of the religious law of the conquering invaders in the limitation of the oppression of conquered aliens. If those present thought of the contemporary history of western rulers, and considered the state of the Netherlands under Philip of Spain, or Central Europe in the eighteenth century, there was little to choose between the degrees of cruelty applied to the weak and defenceless. And that was

an important point. The villages in India had been mostly walled and fortified, and defended themselves by force of arms against oppressive exactions; a state of affairs which lasted to the middle of the nineteenth century, as was observed in the journeys of Sir W. Sleeman in Oudh. Whether Hindu or Moslem rulers were the more oppressive was a very ancient (and, indeed, unprofitable) controversy. Sir Thomas Munro, an eye witness of Indian rule in the eighteenth century, in his well-known account of the State of the Peninsula, had refused to draw any distinction between them. In 1824, as Governor of Madras, he wrote: "I never could discover the least foundation for the assumption that the Hindu assessment had been raised by the Muhammadan Conquest."

He wished to refer to one last point. Mr. Moreland had furnished the Royal Commission on Agriculture with a most valuable memorandum which was published in an Appendix to their Report. As in the present Paper, he pointed out that "at the heart of the problem lies the development of the desire of a higher standard of living." The Commission had accepted the general accuracy of Mr. Moreland's diagnosis which opened up a vista of hope. It was unemployment, from whatever cause it was derived, that was the crowning evil equally in India as in England. Too sombre a view, however, should not be taken. In spite of all the difficulties the peasant had progressed in the art of agriculture. In 1892 Dr. Voelcker had read a Paper to the Society on his enquiries in India, and he used the following words: "In many parts I have seen magnificent agriculture which leaves little or no room for improvement. At its best the agriculture is a picture such as might be a model to many a British farmer." No one who had seen the terrace cultivation on the hillsides of Madras, the reclamation of sandy deserts for perennial irrigation in the Punjab, the spice gardens in the dense forests of Kanara, would deny to those varied races of men industry and intelligence, and courageous endurance. The examples that stood out in his memory lay on the coasts of Ratnagiri. There could be seen, as he himself had seen, the outcastes (the depressed classes) hewing out the living rock, and carrying earth to the hollows they created in order to grow a handful of rice in patches measured by the square foot. Such patience and hopefulness deserved recognition. Perennial irrigation was being pressed forward in almost every tract where conditions were favourable, and when the water was available throughout the year, there was ample work provided for both farmer and labourer. As Mr. Moreland stated, the future of India rested on the liberation of the stores of energy that were dormant in the peasantry. That was the message of hope from the past with which Mr. Moreland concluded. That was also the keynote of the report of the Royal Commission.

Mr. A. Yusuf Ali, C.B.E., said the main proposition of the lecturer's Paper was one with which he agreed, and with which he thought most reasonable people would agree, namely, that the chief problem at the present day was the making of a combined attack on all the varied obstructions to the peasants' prosperity, whether those obstructions arose from past history, from present human environment or from any other cause whatsoever; but when one came to deal with details, he was sorry to say that he would have to disagree with the thesis as set out by the lecturer. In the first place, Mr. Moreland had said that he could not agree about climate or diet as being two important factors which made the Indian peasant what he was. The dogmatism about climate and diet could be carried too far, but, making all allowances, it must be perfectly clear to the lecturer himself, if he referred to his previous experience in India, that climate did play a very important part. To ask why climate, which varied in India, should produce one uniform result ignored the

fact that it did not produce one uniform result. The sturdy, tall Punjab peasant was a very different man from the Bengal peasant who lived in a moist, damp climate. In all history, including the quotation which the lecturer had given from the Moslem historian, it was clear that climate did play, and had played a very important part. With regard to diet, he desired to call the attention of the audience to a table which was printed in the Report of the Royal Commission on Agriculture, which showed that so far from the diet being well-balanced, a scientific study of the Indian diet showed that it was very ill-balanced. In the Deccan the agriculturist subsisted on maize; but mere maize without proper admixture of ghee was apt to produce certain digestive disorders which were far too common, as revealed in the statistics of the hospitals all over India. The Punjab peasant lived rather well, and the result was to be seen in his physique. If one examined the actual figures of ailments in India it would be found that diet had a great deal to do with the stamina and the energy of the people. With regard to custom, social organisation, and the ideas inherited from the past, he did not think the lecturer had laid sufficient stress on those factors. They were very important. What Mr. Moreland had said about the past seemed to throw the whole onus on the unfortunate rulers who had preceded the present rulers of India. Mr. Moreland had himself mentioned some very bright examples from Moslem historians which proved the contrary of his thesis, and he merely accounted for it by saying that those were exceptional rather than general; but personally he would like to point out that in regard to the religious law, particularly of Islam, it was made a special point that in all rural economy it was the duty of the State to take care of the cultivator and to encourage him in every possible way. Hindu political theory was equally insistent on the ryot's position as the basis of the State. He would like to suggest that in these controversies points which were liable to create needless misunderstandings might be left out. He agreed that even where the points were perfectly accurate they might be used for purposes which might rather obstruct the object which all had in view. What was that object, and how could it best be attained? It was very unfortunate, although it might have been necessary, to have limited the reference to the Royal Commission so as to exclude a consideration of land tenures. To his mind, at any rate, the all-important fact about Indian agriculture at the present day, so far as the Government was concerned, turned upon the systems of land tenure, and, if the Commission had had the opportunity of investigating the point, they might have been able to have put forward suggestions which would have been very useful in the future. That, however, had been entirely excluded from their consideration, and the result was that, although the Commission had made some very important recommendations, they were all on points of detail, very few of which could not have been made from a study of the reports of the Agricultural Departments, over one of which Mr. Moreland had presided for so many years.

The whole idea of land seemed to have suffered a revolutionary change. In the East the land was not considered a commercial commodity. In the olden days it had been more a sort of bond for social action and social relations. On that idea, British rule, trying wherever possible to improve the relations of the people and their economic conditions, according to contemporary western standards, had engrafted the notion that land was a commercial commodity; and there was found a great conflict in working out those two ideas. In the minds of the people there was one idea; in the minds of the rulers there was another. In legislation there were all sorts of confusions. When the time came for all these questions of land being considered in a comprehensive spirit, it would not only lead to the amelioration of the peasants' lot and to the improvement of the position of India

generally, but it would also lead to a reconstitution of the financial contracts of the Provinces with the Government of India. Everyone knew that the Provinces were treated very unfairly with regard to land. Some provinces pocketed a large proportion of the produce of the land. Other provinces had to contribute very largely to the central exchequer. Those inequalities had to be redressed. There was yet no scientific study of the question of increment values in India. Urban land was treated practically in the same way as agricultural land. When he had been Finance Minister in Hyderabad he had tried to work out a scheme for inserting into assessment proposals some provisions by which the State could assume rather more control of urban land and treat it on a different footing from agricultural land; and he had given careful consideration to marketing facilities and communications; but, unfortunately, many schemes died with the disappearance of the author of them. He did urge, however, that in any future consideration of the great and comprehensive points which were raised by agricultural policy, the question of the relations of the various grades of producers and of the various grades of land, and of the provinces *inter se*, and with reference to the Government of India, should never be lost sight of.

Next in importance was the consideration of agricultural credit. He thought the State could do a great deal more to provide agricultural credit. It was true that there were the co-operative credit societies, but the reports which had been published showed that a good deal of the work of co-operative credit societies was still in a very unsatisfactory condition and that it would take long years before they got firmly established and before they provided full agricultural credits to farmers and tenants. A great many suggestions were made in the Royal Commission's Report about machinery and research, but he ventured to submit that those affected only the great landholders and did not touch the small farmer.

Finally, there was the question of agricultural education. He was strongly of the opinion that the attempts at agricultural education had been complete or partial failures, and that a definite attempt ought to be made to introduce into the educational system of India a satisfactory provision in that respect for the agricultural population.

The vital part of a Government's relations with the ryot as such could be appraised by complete answers to questions like the following:—What is the burden which the Government throws on the land? How is it distributed between the numerous parties who hold different interests in the land? How is it distributed on different kinds of land, agricultural, *abadi*, pasture, forest, mineral, or industrial? Is the distribution even and equitable, as between Province and Province, District and District, holding and holding? Apart from questions of theories as to economic rents, which are irrelevant in the present position of the land question in India, do land incomes in practice and in fact, bear a greater proportion of State burdens than commercial or industrial or other kinds of income, and, if so, what agencies are there for redressing the inequalities? Does the landed interest of all grades enjoy in practice and in fact, the same facilities of access to modern education and to the sources of power and influence in the State as other interests, and, if not, what is being done in the interests of fair play? These were searching questions, and on the answers to them would depend our judgment as to how far the State had fulfilled its fundamental duties to the cultivator. But these questions all had reference to land tenures and Government land revenue systems—their exclusion from the reference to the Commission rendered the Commission's report, in his opinion, sterile.

Next to what the Government took from the land (as compared with other interests), was the question what the Government gave to the land (as compared

with other interests). The Government was responsible for the system of communications—roads, bridges, railways, post, stage carriages, motor transport, and now air communications. Strategic and export and import considerations had their due importance, but had rural and agricultural interests received due consideration? Currency legislation and financial arrangements had commercial interests in the foreground. Was not agricultural credit of even greater importance, and had adequate facilities been provided for it? He had referred to custom, social organisation, and inherited ideas, as a very important factor in the peasant's present position, but economic facts had a large share in moulding custom and the social *milieu*. The State had the economic position almost entirely in its hands. His plea was that in developing the economic position, they should treat the peasant as a son and not as a step-son.

Sir Richard Burn, C.S.I., remarked that the two previous speakers had
rather strongly the main thesis of the lecture. The lecturer's idea was that the thing which had kept back the Indian peasant was more the unprogressive nature of the schemes of Government than the various factors—diet, climate, etc.—which were sometimes said to be the cause. He did not think either of the two previous speakers had met that argument. The lecturer admitted that both climate and diet did affect the mentality of the peasant, but he pointed out that in the last hundred years some advance had been made. Personally, he did not think either Sir Henry Lawrence or Mr. Yusuf Ali had made any attempt to show that the British Government had been able to influence climate or appreciably to improve the diet of the peasant. If one looked at the history of revenue administration, say, in the United Provinces, it would be found that we had started, as the British generally did, by taking the things over as we found them and making improvements here and there; and concurrently with that the status of the peasant had gradually improved. He would refer to the case of Oudh, which had been annexed in 1856. That had been a particularly ill-ruled State, and there were very fairly accurate statistics regarding cultivation there. Enquiries had been made in the '60's about the tenants, and he thought the fact that within so few years the status of the tenant had improved was a very strong argument in favour of Mr. Moreland's thesis—that the system of government outweighed natural and social defects. It had been suggested to him some days ago that Mr. Moreland appeared to think that Muhammadan rule had been worse than Hindu, but on reading the lecture he did not think that that was in Mr. Moreland's mind at all. Referring again to the United Provinces, and taking the Jhansi district, there had been a very good report written shortly after the Mutiny showing that the Marathas, who had held most of that district, had a system based on a high rack rent. We had made one mistake in the United Provinces in the early days when we came across those rack rents. It had been thought that they were rents which should be collected in full over a series of years. The indigenous system was, however, to fix a rack rent and collect as much as possible and not to carry on arrears from one year to another. The administrators had had to admit that the effects of that mistake in the United Provinces had been very serious. In twenty or thirty years, after we had got the Banda district, the whole district had been sold up for arrears of revenue three times over.

The lecturer had particularly mentioned the Punjab as a part of India in which the crust of apathy caused by mis-rule in the past was wearing thin. Personally, he had recently been reading a little book—the first Village Economic Survey—issued by the Board of Economic Studies in the Punjab. It was a village in the

Amritsar district, and he had been very much struck by the facts which were set out, apparently correctly. The village was mostly owned by Jats, with a few Muhammadans who had other occupations as well as agriculture. The village was conspicuous by bad education. Not a single Jat had reached the matriculation standard, and no member of any caste had gone beyond the matriculation standard; but in the last twenty-five or thirty years it was found that the debt was being steadily paid off and the incidence of the land revenue assessment was steadily decreasing. In whatever way one liked to take it, that village was improving materially. In his own province he could say that the peasant was becoming more and more alert.

On the motion of the Chairman, a hearty vote of thanks was accorded to the lecturer for his interesting address.

THE LECTURER, in acknowledging the vote, remarked that he had said that there was oppression still in India. He did not mean there was oppression in the land revenue system; his own view was that the land revenue system in India from the beginning to the end was wholly and entirely a question of administration. When we had taken it over circumstances had made it as bad as any system could possibly be, but as the result of a hundred years' work, we had turned it into the most scientific system of land taxation that the world had yet seen. With a very slight adjustment of details India could have been financed for the future out of the unearned increment—which was a thing which every economist and every country in the world wanted to do, but they could never do it because of vested interests. Unfortunately, a Joint Committee of Parliament had intervened, and as the result of its intervention the legislatures in the North were now busily creating masses of new vested interests which would render that ideal impossible of attainment.

He should be very sorry indeed to give the impression that he was contrasting Hindu and Moslem rule. It was a question of time. One had to take the Hindu period and Moslem period. As he had said, he did not know what had really happened in the Hindu period, whereas he did know fairly precisely what had happened in the Moslem period. The conclusion he had reached on certain hypotheses was that the Moslem conquest had not made a bit of difference, and that the Hindus had been doing exactly what the Moslems subsequently did.

As for the rest of the discussion, he did not think he was called upon to make any remarks. As he saw it, the point had now been reached where, if only Indians would put their backs into it, they could change the future of the country once and for all. If they would only take the first few steps—which were always the most difficult—they had the future in their own hands.

The meeting then terminated.

OBITUARY.

WILLIAM WORBY BEAUMONT, M.Inst.C.E., M.Inst.E.E., M.Inst.Mech.E.—Mr. Worby Beaumont, the well-known consulting engineer, who had been a member of the Royal Society of Arts since 1893, died on April 14th, in a London nursing home, at the age of 80. He was honorary consulting engineer to the Royal Automobile Club, a member of the Treasury Committee on Horse-power Rating,

of H.M. Gas Traction Committee, and of the Committee of H.M. Surplus Government Property Disposal Board. Born near Manchester, in 1848, he was educated at Reading and Ipswich, and received his practical engineering training at the Reading Iron Works and later as improver in the works of Messrs. Ransomes, Sims & Jeffries of Ipswich. He was afterwards assistant to the late Robert Mallet, C.E., F.R.S. For ten years he was joint editor of the *Engineer*, and then returned to private practice twenty-five years ago. He was technical adviser for twelve years to the Commissioner of Police of the Metropolis on all motor vehicle questions, and was appointed arbitrator in numerous cases by the Board of Trade and the High Court. He was vice-president of the jury at the Brussels Exhibition of 1910, vice-chairman of the London Electric Vehicle Committee, and vice-chairman of the Roads Improvement Association.

In 1894 Mr. Worby Beaumont read a paper before the Society on "The Automatic Balance of Reciprocating Machinery," for which he was awarded a silver medal, and this was followed by a series of papers in subsequent years on subjects connected with motor vehicles and street traffic, the last paper, on "Modern Motor Car Design," having been delivered only last year.

NOTES ON BOOKS.

LIFE AND WORK OF THE PEOPLE OF ENGLAND. THE FOURTEENTH CENTURY By Dorothy Hartley and Margaret Elliot.

LIFE AND WORK OF THE PEOPLE OF ENGLAND. THE SEVENTEENTH CENTURY. By Dorothy Hartley and Margaret Elliott. London: B. T. Batsford, Ltd Each volume 4*s*. 6*d*. net, boards; or in cloth, 5*s*. 6*d*. net.

Three fallacious attitudes towards the past are customarily adopted at the present time.* First there is the "romance of modern industry" attitude, which treats the past as barbarous and to be pitied. Secondly, there is the "good old days" attitude, which makes its supporters exclaim with Peacock: "Don't talk to me about anything that has happened within the last two thousand years." Thirdly, there is the "Shakespeare in modern dress" attitude, according to which nothing ever changes at all. The truth presumably is that things do change, neither altogether for the better nor altogether for the worse.

I believe I have named the three points of view in the order in which they are usually set before us. At school we are made to believe in progress; nor do we take much persuading when in our 'teens that invention and progress are synonymous. At the university scepticism sets in, and we fall under the spell of Hellas. In the wide world we find everything going on as it went on in the days of Isaiah, in the days of Horace, in the days of Chaucer.

There is no doubt that the "Life and Work" series does its best—a good best—to put an end to a bad tradition. It breathes reality into that barbarous and pitiful past, which turns out to have been deserving of less pity and more curiosity. The fourteenth century, of course, was a critical time in England from the point of view of society, as the authoresses do not fail to remark; war and pestilence precipitated changes of far-reaching importance.

With regard to the excellent pictures with which every phase of the life of the people is illustrated, I have only one comment to make. Might it not have been worth including among them a few photographs of fourteenth-century architecture and works of art? There is a photograph of a model of the hall at Penshurst:

why not one of Penshurst itself? Thus might the remoteness of the age seem less great. The pictures are homely and lively enough, but with all the people in fancy dress, so to speak, it might have been advisable to remind young readers as forcibly as possible that many churches familiar to them were conceived and built in the period of the Hundred Years' War.

A pleasant sense of humour pervades the letterpress. Under Donkeys: "Being fond of animals, we regret that in every picture of every donkey in every century a donkey is being whacked."

The present reviewer is awestruck to learn that the most popular winter game "for both sexes" (of the nobility) was chess. Another nail in the coffin of our illusions about progress!

The volume on the seventeenth century is not inferior to its predecessors in the series. An imaginative teacher should find it most valuable: it provides just the right texts for many an interesting lesson. One, for instance, on a perennial type of conservatism. "Many people thought, too, that in spite of guns the sturdy bow and arrows ought not to be despised in warfare."

The seventeenth century was very artistic and civilised, yet, like the eighteenth, not very clean. "Gone are the cheerful bathing scenes of the earlier M.S.S Seventeenth-century people wash in their own rooms and not much."

As before, the pictures are fascinating, and should stimulate every intelligent boy and girl who opens the book into pursuing further researches into his or her favourite subject; amateurs of the fire engine, if such exist, will be entranced by the operations shown at the bottom of plate 38. Football enthusiasts will see from plate 16 that their game was originally played in a costume not less attractive than that worn by the dignified protagonists of cricket.

A little more emphasis on the creative aspect of the century might not have come amiss. Children do not hear enough about either Sir Isaac Newton or Inigo Jones: two of the greatest Englishmen of any age. But it would be wrong-headed to labour the point; these books are admirable; they generate and maintain just the right atmosphere of "life and work."

The feeling of the "quaintness" of many of the proceedings described is not to be avoided. The twentieth century is as quaint as any; the Greeks and Romans alone have been sufficiently matter-of-fact in their respective ways to escape this particular contamination. If the books of the present series were intended to form a *Kulturgeschichte* they would have to speak of the highly intellectual minority in the seventeenth century which was anything but quaint; with "life and work" at large of course it was different.

What was said above about photographs would apply here too. The Banqueting Hall might have figured among the illustrations; also, perhaps, some contemporary portraits of notabilities. It is true that the engravings begin to look more modern. The riding school, after Van Diepenbeck, is very *chic*. The travelling grinder, after Teniers, is merely smarter than the gentlemen we have all seen and admired.

There is no excuse left for teachers to lay undue emphasis in the old style on the military operations with which the minds of children have been so unwisely regaled.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, APRIL 29. .Actuaries, Institute of, Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. J. G. Parker, "Financial Conditions in Canada as affecting Life Assurance."

Geographical Society, at Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. W. R. Rickmers, "The Alai-Pamirs in 1913 and 1928."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Dr. Vilhjalmar Stefansson, "Abolishing the Arctic."

At King's College, Strand, W.C. 5.30 p.m. Prof.

Pedro Salinas, "Thirty Years of Spanish Literature (1898-1929)." (Lecture I.)
At the London School of Economics, Houghton Street, W.C. 5.30 p.m. "Some Modern Philosophies of History"—(Lecture I) Prof. H. J. Laski, "Marx."
At University College, Gower Street, W.C. 5.15 p.m. Prof. Dr. E. Mellanby, "Drug-like Actions of some Food Constituents." (Lecture I.)
5.30 p.m. Prof. H. F. Baker, "Geometry: a Brief Review." (Lecture I.)

TUESDAY, APRIL 30..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Mr. J. H. Driberg, "Gala Colonists of the Sixteenth Century."

Illuminating Engineering Society, at Holophane, Ltd., Elverton Street, Westminster S.W. 6.30 p.m. Dr S. English, "Some further Properties of Glass and their Application in Illuminating Engineering." Demonstration by Mr. Gillespie Williams of various novel applications of Coloured Light.

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture I.)
At University College, Gower Street, W.C. 5.15 p.m. Prof. Dr. E. Mellanby, "Drug-like Actions of some Food Constituents." (Lecture II.)

WEDNESDAY, MAY 1..Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Dr. R. S. Morrell and Mr. S Marks, "The Determination of Organic Peroxides." (2) Mr. J. W. Croxford, "Differential Halogen Absorption of Oils and Fats." (3) Dr W. R. Schoeller and Mr. C. Jahn, "A New Method for the Separation of Small Quantities of Tantalum and Niobium from Titanium." (4) Mr. H. R. Ambler, "The Analysis of Small Samples of Gas."

British Academy, Burlington Gardens, W. 5 p.m. Prof. Dr. J. Dover Wilson, "The Elizabethan Shakespeare."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Meeting of Wireless Section.
Royal Institution, 21, Albemarle Street, W. 5 p.m. Annual Meeting.

Sanitary Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7.30 p.m. Mr. Frank Hunt, "The Clearance of Slum Areas."

University of London, at Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Dr. Vilhjalmar Stefansson, "The Northward Course of Empire."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Dr. Hubert Hall, "The Nature, Value and Uses of English Judicial Records as Sources of Economic and Social Information." (Lecture I.)
At University College, Gower Street, W.C. 5 p.m. Lt.-Col. J. S. Stewart-Wallace, "Registration of Title to Land as a Humane Study."
5.15 p.m. Prof. Dr. E. Mellanby, "Drug-like Actions of Some Food Constituents." (Lecture III.)
5.30 p.m. Mr. Geoffrey Peto, "Present Day Problems: The Local Government Reform Scheme and De-rating."

THURSDAY, MAY 2..Chemical Society, Burlington House W. 8 p.m. (1) Messrs. I. M. Heilbron, W. M. Owens and I. A. Simpson, "The Unsaponifiable Matter from the Oils of Elasmobranch Fish—Part V: The Constitution of Squalene as deduced from its Degradation Products. (2) Messrs. I. M. Heilbron and A. Thompson, "The Unsaponifiable matter from the oils of Elasmobranch Fish—Part VI: The Constitution of Squalene as Deduced from a Study of the Decahydrosqualenes." (3) Messrs. I. M. Heilbron and W. A. Sexton, "Studies in the Sterol Group—Part III: The Acetylation and Catalytic Hydrogenation of Ergosterol." (4) Messrs. I. M. Heilbron, W. A. Sexton and F. S. Spring, "Studies in the Sterol Group—Part IV: The Existence of Isomeric naturally occurring Ergosterols." (5) Messrs. I. M. Heilbron and F. Irving, "Styrypyrylium Salts—Part XI: The Determination of the Reactive Group in Ketones of the type $CH_3.CO.CH_2R$ by means of the Benzo-β-Naphthaspiropyran colour change. (6) Messrs. G. A. R. Kon and R. P. Linstead, "Catalytic Influences in three-carbon Tautomerism—Part I' Sodium Alkyloxides."

Iron and Steel Institute, at the Institution of Civil Engineers, Great George Street, S.W. 10 a.m. Prof Dr. Henry Louis, Presidential Address. Committee's First Report on Blast Furnace Plant and Practice Mr. E. H. Lewis, "Twenty Months' Results of Dry Blast Operation." Mr. W. E. Simons, "The A.I.B Sinter Plant at Messrs. Guest, Keen and Nettlefolds Ltd., Cardiff Works."
2.30 p.m. Messrs. R. H. Greaves, H. R. Abram and S. H. Rees, "The Erosion of Guns." Mr. H. Sutton "The Influence of Pickling Operations on the Properties of Steel." Mr. G. A. Hankins and Miss G. W. Ford, "The Mechanical and Metallurgical Properties of Spring Steels as revealed by Laboratory Tests."

Linnean Society, Burlington House, W. 5 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Pedro Salinas, "Thirty Years of Spanish Literature (1898-1929)." (Lecture II.)
5.30 p.m. Dr. Stanley A. Cook, "The Religion of the Old Testament in its Historical Setting." (Lecture I.)
5.30 p.m. Mr. Ifor L. Evans, "Agrarian Reform in the Danubian Countries." (Lecture I.)
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Sir Walter Scott and the Origins of the Historical Romance in Poland." (Lecture I.)
At St. Thomas's Hospital, Albert Embankment, S.E. 5 p.m. Prof. S. J. Cowell, "Dietetics" (Lecture I.)
At University College, Gower Street, W.C. 5.30 p.m. Prof. J. Petersen, "Faust" (in German). (Lecture I.)

FRIDAY, MAY 3. Automobile Engineers, Institution of, at the ROYAL SOCIETY of ARTS, Adelphi, W.C. 7.45 p.m. Mr. H. F. L. Orcutt, "The Production and application of Ground Gears." (Joint Meeting with the Institution of Production Engineers.)

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Meeting of Meter and Instrument Section Mr. G. D. Malcolm, Chairman's Address.

Geologists' Association, at the University College Gower Street, W.C. 7.30 p.m. Dr. S. W. Wooldridge and Mr. A. J. Bull, "The Arun Gap and Lower Greensand around Pulborough."

Iron and Steel Institute, at the Institution of Civil Engineers, Great George Street, S.W. 10 a.m. The Hon. Sir Charles A. Parsons and Mr. H. M Duncan, "A New Method for the Production of Sound Steel." Committee's Third Report on Heterogeneity of Steel Ingots. Mr. J. M. Robertson, "The Micro-structure of Rapidly Cooled Steel." Mr. Dartrey Lewis, "The Transformation of Austenite into Martensite in a 0.8 per cent. Carbon Steel." Mr A. L. Norbury, "Constitutional Diagrams for Cast Irons and Quenched Steels."
2.30 p.m. Mr. G. R. Bolsover, "Brittleness in Mild Steel." Mr. L. B. Pfeil, "The Oxidation of Iron and Steel at High Temperatures." Messrs. E. G. Herbert and P. Whitaker, "The Differential Method for Measuring the Thickness of Hard Cases without Sectioning them." Messrs. T. E. Rooney and G. Barr, "A Method for the Estimation of Hydrogen in Steel."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr. Henry Berry, "London's Water"
At the Chamber of Commerce, Birmingham. 7.30 p.m. Annual Meeting.
Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Anniversary Meeting. Presidential Address.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Sir Daniel Hall, "The Garden Tulip."

University of London, at King's College, Strand, W.C. 5.30 p.m. M. Fernand Gregh, "La Conception Actuelle de Victor Hugo."
5.30 p.m. Prof. A. Mawer, "Problems of Place-Name Study in the Light of Five Years' Work of the English Place-Name Survey." (Lecture I.)
5.30 p.m. Admiral Mark Kerr, "The Greek Naval Leaders and their Exploits."
At University College, Gower Street, W.C. 4 p.m. Prof. Dr. A. J. Hall, "Some of the Sequels of Epidemic Encephalitis (Lethargica)." (Lecture I.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3989. VOL. LXXVII.

FRIDAY, MAY 3rd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK

MONDAY, MAY 6th, at 8 p.m. (Aldred Lecture.) SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic Movements in Asia." (Lecture III.)

WEDNESDAY, MAY 8th, at 8 p.m. (Ordinary Meeting.) CHARLES J. FFOULKES, O.B.E., F.S.A., Curator of the Armouries, Tower of London, "War and the Arts." PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, will preside.

FRIDAY, MAY 10th, at 4.30 p.m. (Sir George Birdwood Memorial Lecture.) CAPTAIN P. JOHNSTON-SAINT, M.A. (Cantab.), F.R.S.(Edin.), I.A.(retd.), of the Wellcome Historical Medical Museum, "An Outline of the History of Medicine in India." SIR E. DENISON ROSS, C.I.E., Ph.D., will preside. The lecture will be illustrated by lantern slides.

Tea will be served in the library before the meeting from 4 o'clock.

NINETEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 24th, 1929. PROFESSOR T. PERCY NUNN, M.A., D.Sc., Litt.D., in the Chair.

A paper on "Recent Developments in Educational Broadcasting" was read by MR. LYNTON FLETCHER, B.A., of the British Broadcasting Corporation. The paper and discussion will be published in the *Journal* on June 28th.

ALDRED LECTURES.

MONDAY, APRIL 29th, 1929. SIR E. DENISON ROSS, C.I.E., Ph.D., Director of the School of Oriental Studies, University of London, delivered the second of his course of four lectures on "Nomadic Movements in Asia." The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

TENTH ORDINARY MEETING.

TRUEMAN WOOD LECTURE.

WEDNESDAY, FEBRUARY 6TH, 1929.

E. F. C. TRENCH, Esq., C.B.E., M.Inst.C.E., Consulting Engineer to the L.M.S. Railway, in the Chair.

THE CHAIRMAN said that Sir Alfred Ewing required no introduction from him; few men were so well known among engineers and others engaged in the work which was the subject matter of the lecture. He had sat under Sir Alfred's Chairmanship now for several years in connection with the Bridge Stress Committee, and he could assure the audience that if they were as interested in what Sir Alfred had to tell them as the Committee had been in the work which Sir Alfred had made them do, they would be exceedingly fortunate.

The following lecture was then delivered:

THE VIBRATIONS OF RAILWAY BRIDGES: AN EXAMPLE OF CO-OPERATIVE RESEARCH.

By SIR J. ALFRED EWING, K.C.B., M.A., LL.D., D.Sc., F.R.S., M.Inst.C.E., Principal and Vice-Chancellor of the University of Edinburgh, and Chairman of the Bridge Stress Committee.

Since the Spring of 1923, nearly six years ago, it has been my privilege to preside over the Bridge Stress Committee, which was then appointed to deal with an old and puzzling problem of engineering—what is called the "impact" or dynamic action of a train moving at high speed over a railway bridge. When I was invited to deliver this lecture, founded in memory of your honoured former Secretary, whose recent death is deplored by his many friends, it seemed suitable that I should take occasion to speak about the Committee's work. It deals with a question that naturally comes within the ambit of the Society's interest—a question where practice seeks illumination and guidance from theory. As it happens, the occasion is particularly opportune, for the Report of the Committee—a voluminous and in all senses a weighty document—has just been published. In dealing with so intricate a matter in a single hour I cannot do more than touch briefly on some of the more salient points.

First, I would have you notice that this research is of a kind that could not have been achieved without co-operation. Its parent was the Department of Scientific and Industrial Research, which brought together the British railway

groups, securing not only their goodwill and their financial help, but also all the practical facilities without which the experiments could not have been carried out. The Committee was constituted and has done its work under the auspices of the Department. It included engineers of experience and experts in theory, persons well fitted to plan the experiments and to analyse the results. We were very happy, I venture to say, in our personnel: among our members was Mr. Trench, who is in the chair to-night, recently President of the Institution of Civil Engineers. He, with Mr. Brown, Mr. Ellson and Mr Cookson, represented the four great railway companies of the island, which, as a good Scotsman, I must not call England. Then we had Sir Robert Gales, member of a well-known firm of consultants; also Prof Dalby, Prof. Inglis and Mr. Southwell—experts who have not forgotten their mathematics. And we had Colonel Sir John Pringle, whose unrivalled knowledge of the misadventures of railways gave his advice particular emphasis and value. A report signed by Sir John Pringle is not likely to contain recommendations that are unduly rash.

We soon realised that our problem involved questions of locomotive design and the conditions that govern it. The Committee was accordingly strengthened—greatly strengthened—by the addition of Sir Henry Fowler. We also saw that it was necessary to undertake an extensive series of tests of railway bridges; so our first act was to set up a staff of engineers. About a dozen young engineers were selected—products of the admirable teaching which young engineers now enjoy—and at their head we placed Mr. Conrad Gribble, of whom the Report most truly says that his intimate knowledge of bridge design is only one of many qualities which have combined to make him an exceptionally suitable head of such an enquiry. To myself the close association with the members of the Committee and with Mr. Gribble and his staff during the long process of carrying out the experiments, discussing the significance of results, and settling the terms of the Report, has been an unqualified pleasure. Rarely, I think, can it have happened in the history of committees that one composed of elements so various and engaged in an enquiry so protracted and so difficult, has found its members' interest equally well sustained from start to finish, and has in the end issued a wholly unanimous Report.

The impact, as it is called, of a moving load is an old problem. As a young student of engineering more than half a century ago I used to be taught the simple rule that for a moving load you had simply to multiply by two. Simplicity is the only virtue of that exceedingly fallacious rule. It is easy enough to see how such a rule was framed. Think of a spiral spring hanging from a fixed support, and what happens when you suddenly hang on a load. Down goes the load, and after a series of oscillations, it settles in a mid-position, just half as far down as it went at first. You have there a quite obvious example of the simple rule. But it would be a fallacy to apply that

to a railway bridge. A bridge does not dip twice as far when a train is passing as when the train stands upon it. Still, there is a well-founded engineering instinct that there ought to be some allowance for impact; that the swiftly moving load, somehow or other, does produce a dynamic effect which makes an addition to the stress that would be experienced if the load were standing on the bridge, or crawling over it.

Let me explain at the outset that we are not dealing here with any question of fatigue. We are dealing simply with the question, what additional stress do the members of the bridge have to bear because the load is moving, and also (this is highly important) because within the load itself there are parts that are moving relatively to one another. Early consideration of the problem by American bridge-builders gave rise to what is known as the Pencoyd formula, according to which you should add a certain fraction of the moving load as an allowance for impact. The rule was to add the fraction $\frac{300}{300+L}$, where L is the span in feet. Obviously if L is very small this fraction is near unity. In other words, with a very short bridge the Pencoyd rule means doubling the applied load. On the other hand, as L gets longer the fraction gets less, and if the span were 300 feet the fraction to be added would be just one half.

There are many similar formulas involving much the same idea but different in their particular numerical values. All such formulas are fundamentally unsound. The fact is that a perfectly smooth rolling load running over a bridge on smooth rails would cause almost no impact effect at all. That has been shown by the theoretical investigations of Prof. Inglis, whose services to our Committee I cannot overrate; and the validity of his theory has been demonstrated time and time again in the course of our experiments.

Why is it, then, that in a railway bridge a substantial amount of oscillation is in fact set up during the passage of a train? Mainly—almost wholly—because of the hammer-blow of the locomotive. The phrase "hammer-blow" is one with which, I imagine, most of this audience are familiar. It is a periodic variation of the vertical force exerted on the rails by the locomotive, which arises from the fact that balance weights have been put in the wheels for the purpose of neutralising to some extent the horizontal momentum of reciprocating parts, such as the pistons, piston rods, and connecting rods, which would otherwise tend to cause a horizontal swaying of the locomotive. The presence of the balance weights gives rise to a sinusoidal variation of vertical force which, in extreme cases, may be as much as 25 tons, alternately added to and subtracted from the actual weight of the engine. We made many experiments with a locomotive in which even that figure was exceeded.

Much may be done to reduce this hammer-blow by a careful consideration of the balancing problem, even in a two-cylinder engine, and still more may be done to reduce it by using three or four cylinders instead of two. Mr. Gresley's

powerful "Pacific" engines, for example, which were in service on the L.N.E. Railway before our enquiry began, illustrate well how much may be done to avoid hammer-blow by the judicious use of three cylinders.

It is pleasant to know that while our conclusions were still unpublished, we were able, chiefly through the intermediary action of Sir Henry Fowler, to bring them to the notice of locomotive designers, with good results upon existing practice in the matter of escaping excessive and quite unnecessary hammer-blow.

Among previous investigations of the same general question mention should be made of the experiments of the American Railway Engineers' Association, whose Report was published in 1910, and the work of the Indian Railway Board, which extended from 1917 to 1921. Those enquiries established the importance of hammer-blow, but they were not carried far enough to give working rules of a satisfactory kind for the guidance of railway engineers.

In the course of our experiments we tested fifty-two bridges of all sorts, with spans ranging from 16½ft. up to 345ft. Over these we ran a variety of locomotives, lent, of course, by the railway companies, and selected to exert various amounts of hammer-blow, some of them giving specially large amounts. We used several forms of deflectometer and strainmeter. For strainmeters, to be attached to the members, we had, in particular, two types—the Fereday-Palmer type, and another type devised by the Cambridge Scientific Instrument Company. In the Fereday-Palmer instrument the recording is photographic, and very effective it is. In the Cambridge Instrument Company's instrument, a method invented by a member of that firm, Mr. Collins, is used, according to which a fine point scribes, with very little friction, a line upon a moving strip of photographic film. The recording is mechanical; there is no photography in the process. We also used in a few experiments an electric form of strainmeter devised by Mr. Thomas, of the National Physical Laboratory, and modified in its application to our purpose by Mr. Moullin. It was specially valuable as an instrument of comparison, for checking errors in the other types that arose from the inertia of their mechanical working parts. As for deflectometers, the problem is comparatively simple. There again we used the Collins method of recording on a moving strip of photographic film, but it was a purely mechanical record. We found no serious difficulty in getting a deflectometer to record with accuracy every phase in the movement of the middle of the bridge. I do not intend to take up the short time at my disposal by dealing with details of instruments, and the checking of instruments. You will find that fully gone into in the Report.

Now, what is the action of the hammer-blow? The essential characteristic is that during the passage of the load you have superposed upon the gravitational action of the moving weight an oscillating variation of vertical force, whose complete period is represented by a distance equal to the circumference of the driving wheels. Lord Balfour, in his introductory note to the Report,

compares this action very appropriately to that which occurs when a man wheels a barrow across a plank. The plank has a natural period of vibration. When the man and the barrow are on it, it still tends to vibrate, but in a slower period, because it is now more heavily loaded. If the barrow could move without the man you would have an extremely smooth deflection of the plank with no vibration to speak of; but the action of the man's feet produces much the same effect as the hammer-blow of a locomotive; and so you have the plank set into oscillation. Everybody knows that in such a case the effect may be immensely increased, if the plank is a long one, by resonance; that is to say, there may be a cumulative effect arising through synchronism between the period of the man's steps and the natural period of oscillation of the loaded plank. The same thing is true of the loaded bridge. A bridge loaded with a locomotive and train has a fairly well-defined natural period of oscillation. Obviously, unless the bridge is an excessively short one, it will frequently happen that the locomotive is crossing at just the speed which is fitted to make its periodic hammer-blows produce resonance. In a very short bridge this will not occur, because there, even with the load on it, the bridge tends to vibrate more quickly than any frequency of hammer-blow that can be reached in the motion of the locomotive. The highest frequency that is reached in express running is something like six periods per second. We dealt with some bridges so short that the natural frequency of vibration was more like 10 or 12 per second. In a case such as that there can be no resonance, because the bridge has too high a natural frequency, but when the span is more than 30ft. or so some resonance is liable to occur. When you get up into the region of 100 to 200ft. span, you may have immense developments of resonance, and it is in such bridges that the greatest impact effects are found. With longer spans still—although there may still be resonance—it occurs only when the speed of the train is so slow that the hammer-blow is small, and therefore it becomes comparatively unimportant. It is in the middle region of spans, especially the region between 100 and 200ft. or thereabouts, that the effects of resonance are most serious.

I shall begin by showing some complete typical diagrams, as we got them in our recorded tests of the deflections of bridges. I ought first to say that we made many measurements of stress as well as deflection, but we found that the accordance between deflection readings and stress readings in the main tension and compression members was so perfect that deflection readings were quite enough for the purpose. It was only in dealing with web members, to ascertain the influence of impact on the shearing stresses, that we had to resort to stress measurements, because there, of course, deflection by itself did not tell us anything.

Figures 1 and 2 are typical examples of the recorded deflection when a locomotive passes over a bridge. In Fig. 1 the bridge is a fairly long one (about 170 feet), and is set into resonant oscillation because it has a natural

period which agrees with the period of hammer-blow; in other words, the engine is running at what we call the *critical* speed. In Fig. 2 the bridge has a span of only about 30 feet and is too short to develop resonance, but the engine is running at a high speed and each hammer-blow produces a well-marked individual effect. Both figures show the deflection at the middle of the bridge in relation to the time. On the left the curve begins to dip when the front wheels of the locomotive enter the bridge. On the right the dip

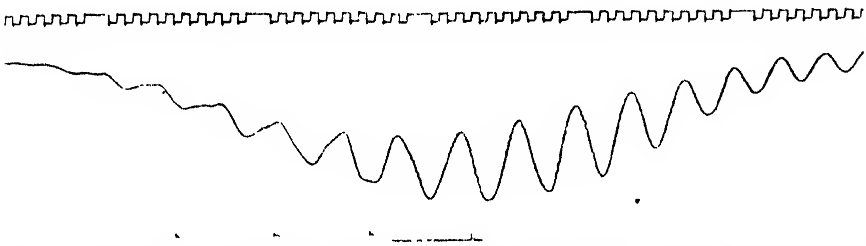

FIG. 1.—Typical record of the Deflection of a Bridge during the passage **of a locomotive at** the critical speed

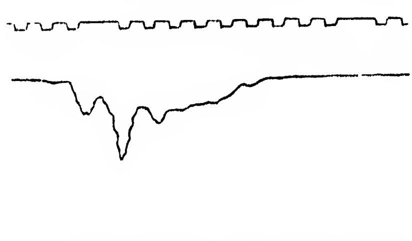

FIG. 2.—**Record of Deflection** of a short bridge during the passage of **a locomotive at high** speed.

ceases when the last wheels of the tender leave the bridge, but you observe that in Fig. 1 the bridge is left oscillating after the engine has passed off. The time scale at the top of each figure shows tenths of a second, each complete second being indicated by the omission of the tenth mark. The length of the deflected portion in each figure corresponds to the span plus the wheel base of the locomotive and tender. Notice in Fig. 1 the gradual building up of oscillation, which reaches its maximum soon after the engine has passed the middle of the bridge. The residual oscillation seen on the right would soon disappear through the influence of damping if the record were continued. In Fig. 2 the engine also enters from the left and you see three well-marked dips which are direct effects of heavy hammer-blows on a short and rather flexible bridge. After that, no more hammer-blows are felt, for the driving wheels have passed off and the remainder of the curve is due to the tender. The locomotive used here was of the 0—8—0 type, with much hammer-blow. Its four coupled pairs of drivers had a wheel base of about 15 feet. In the first of the three blows, the leading drivers were operating, in the second all

four are felt, and the third blow comes as the last pair were about to pass off. The remainder of the diagram is the deflection of the bridge under the tender. There is practically no resonance in Fig. 2. Each blow simply produces a dip proportional to the blow itself. It may be said to act as a static force without any dynamic magnification. In Fig. 1, on the other hand, there is much dynamic magnification. The blows are individually lighter, for the speed of the engine is less, but they produce a cumulative effect that comes from the synchronism between their period and the natural period of the bridge. Towards the end the vibration becomes reduced, partly because of damping and partly because the natural period of the bridge alters, becoming quicker as the locomotive is passing off.

Let us now consider the development of resonant vibrations under the influence of synchronous hammer-blows. In Figs. 3, 4 and 5 are a group of theoretical deflection curves, calculated by Professor Inglis for a bridge having the same span and natural period of vibration as one of those which we actually tested. He has also taken for hammer-blow the amount that was delivered by one of the engines which were used in the tests. In Fig. 4 he shows how oscillations would be developed if there were no damping, and if the bridge retained a uniform period of oscillation which agreed with the period of the blows. In Fig. 4 he shows how the result is affected by damping, that is to say, by a dissipation of energy such as actually occurs in any bridge set into oscillation; and in Fig. 5 he shows the kind of oscillation which would be set up by a single mass of the same weight running smoothly across the bridge at a high speed without any hammer-blow. By comparing these figures you will see (1) what a very small amount of oscillation is caused when there is no hammer-blow, and (2) what immense effects the hammer-blow may cause when the conditions are favourable for resonance.

Why then is it that we do not have a really dangerous amount of oscillation developed in railway bridges? It is mainly for two reasons: first, because there is never a perfectly sustained synchronism for any long time. While the locomotive is crossing the bridge the natural period of oscillation necessarily changes. When the heavy mass is at the middle, the oscillation is slower than when the locomotive is just entering or just leaving. This variation in the period of the loaded bridge itself does much to check the building up of resonant oscillations. Again, there is the influence of damping, which arises from several different causes. The bridge is not a perfectly elastic structure. If one end is held fixed, the other end slides backwards and forwards when the bridge oscillates, and its sliding is opposed by friction. Further, any oscillation that is set up in the bridge is communicated through the piers to the surrounding ground. You have only to stand near a bridge when a train is passing to be aware that energy is being communicated to the ground under your feet. There is still another cause of damping which, as our investigations have shown, is of immense importance, namely, the damping that occurs within

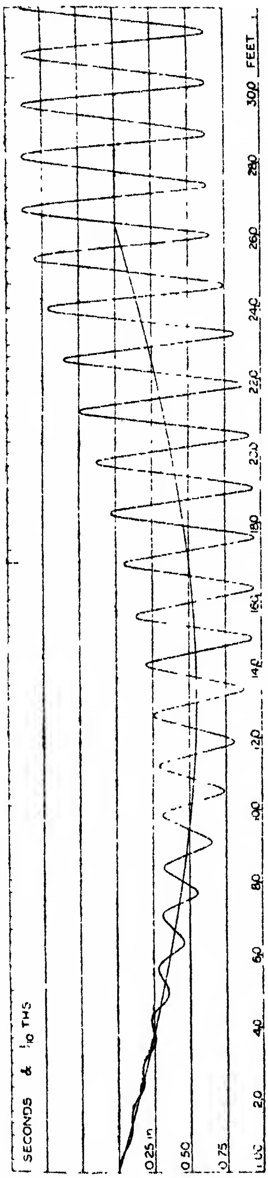

FIG 3 ‡.—Undamped synchronous oscillation

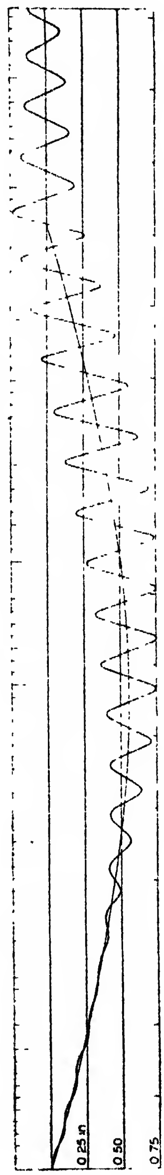

FIG. 4‡.—Damped synchronous oscillation

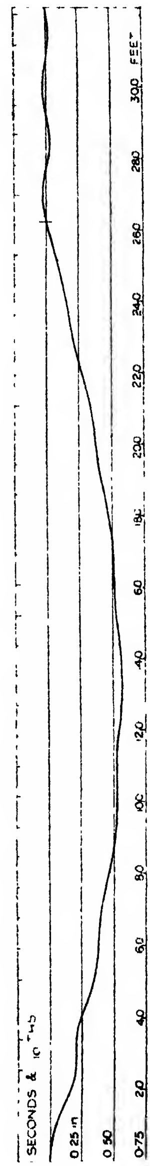

FIG. 5‡.—Oscillation due to a moving mass without hammer-blow Speed 7.5 m p h

the train itself through the action of the springs. In a locomotive the chief part of the mass is carried on stiff springs that work with considerable friction, and when the oscillations of the bridge become sufficiently violent these springs are set into action. This affects the natural period of the bridge

‡ Reproduced by kind permission of the Secretary of the Royal Society from a Paper on "Oscillations in a Bridge caused by the Passage of a Locomotive" by C. E. Inglis (Proc. Roy. Soc. A. Vol. 118, 1928).

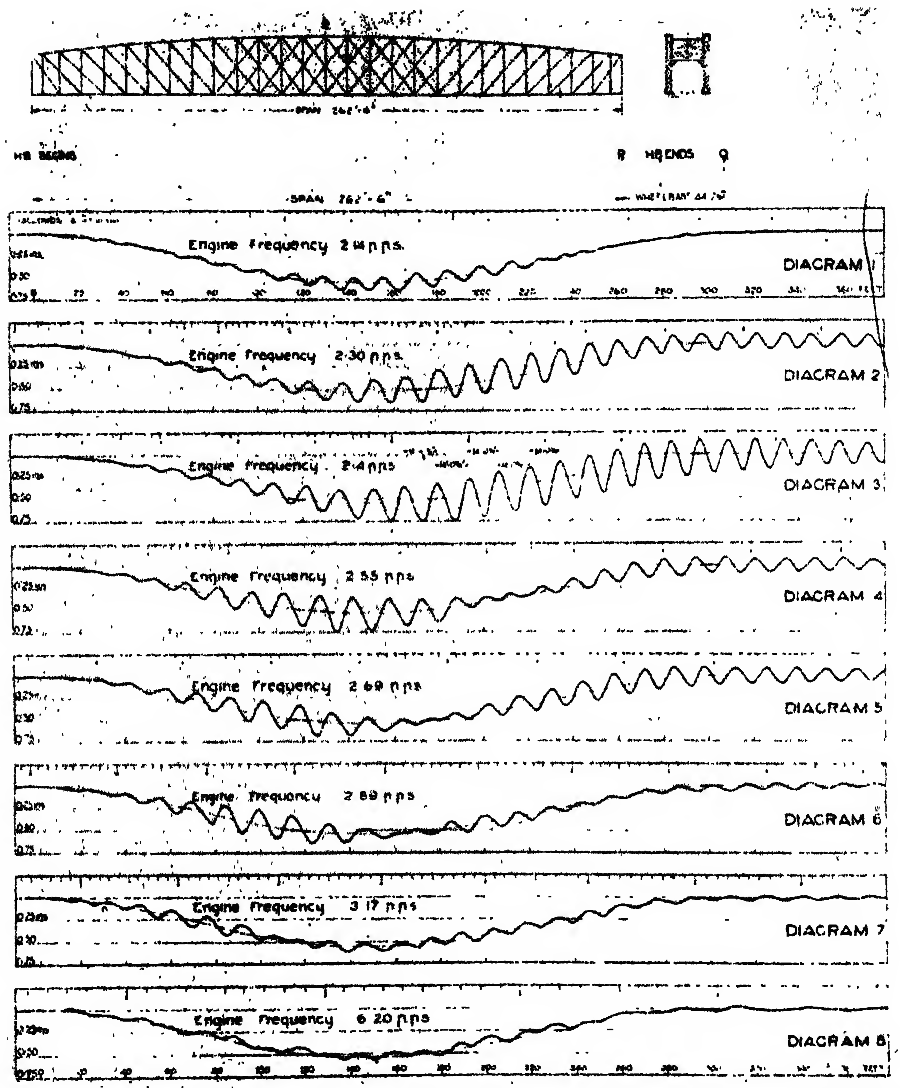

FIG. 6.—Records of Deflection of Newark Dyke Bridge for a locomotive passing at various speeds.

oscillations, and it also introduces a supplementary kind of damping which is very influential in preventing excessive oscillation on the part of the bridge.

Figure 6 shows a series of tests of a bridge at Newark Dyke of 262 feet span, carrying a single track symmetrically placed between two girders. The deflections of both girders were found to be in perfect agreement. The figure contains a series of diagrams showing the effect of running a heavy goods locomotive with 4ft. 6in. driving wheels over the bridge at various speeds—

first at a speed less than that corresponding to synchronism, then at speeds favourable to resonance, and so on up to speeds very much higher. You will see that when the engine frequency is 2.14 periods per second there is comparatively little resonance. There is more when the engine frequency becomes 2.3, and much more when it becomes 2.4. Then when it is increased to 2.55, the resonance is greatly less, and it diminishes with further increase in the speed until at 6.2 periods per second very little oscillation is seen, although at that high speed the actual hammer-blow is more than six times greater than it was at the speed of 2.4, when the resonant oscillations were so large. A comparison of these diagrams shows that 2.4 periods per second is the critical speed, at which resonance is much more marked than when the speed is either higher or lower. This action is typical of any long bridge.

In another test we ran engines of five different types, with various amounts of hammer-blow, across a bridge of 210 feet span, in order to test the correspondence between the amount of hammer-blow and the amount of oscillation produced. Each of the engines was run at the critical speed, that is to say, at the speed best adapted for producing resonance, and we found, under these conditions, that there was a close proportionality between the amount of the hammer-blow and the amount of cumulative oscillation which became set up in the bridge.

In the course of our experiments we constructed an oscillator for the purpose of setting bridges into oscillation without the passing of a locomotive. The bridge oscillator consisted of a truck carrying a frame on which was mounted a pair of geared axles running in opposite directions and carrying heavy weights, which could be varied in amount. The weights were placed out of centre so that in the course of their revolution they imitated the effects of hammer-blow, but without any movement on the part of the truck which carried them. They were electrically driven, with the truck clamped to the rails at or near the middle of the bridge. We could place this on a bridge and could either test the bridge without other load or could have a locomotive standing near so as to make the condition of loading the same as when the locomotive was passing over. By varying the amounts of the revolving mass we could vary the hammer-blow to any desired extent. Figure 7 shows a set of four records taken with this oscillator on a bridge of 210 feet span. The revolving masses were changed from 100 lbs. to 200, 300, and 400, and were in each case run at the critical speed so as to produce all the resonance possible, giving amounts of hammer-blow equivalent to a range from 0.7 to 2.8 tons. The diagram shows that, within the limits of experimental error, the amplitude of oscillation is proportional to the hammer-blow.

The bridge oscillator exhibited very directly the effects of damping. A constant state of oscillation was established when the energy put in by the oscillator was being dissipated by the bridge at the same rate. Further, the oscillator was of great service as a means of measuring the frequency of the bridge, both in its loaded and unloaded state.

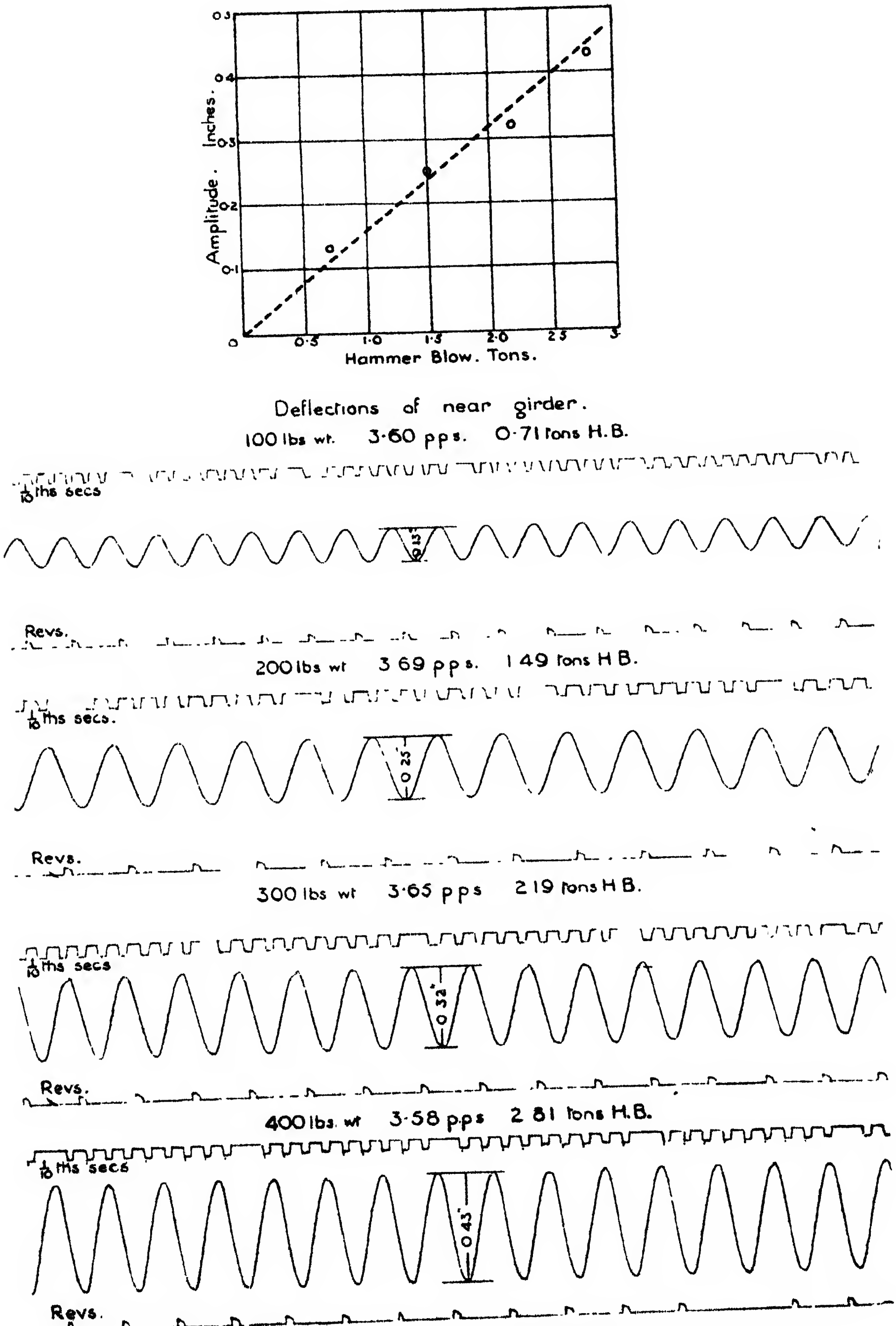

FIG. 7.—Action of Bridge-oscillator.

Fig. 8* —Model bridge.

Figure 8 shows another appliance which was of considerable service—a model bridge built by Professor Inglis in his laboratory at Cambridge, consisting of a pair of rails extending over a span of 12 feet. Across it passed a little truck which was accelerated by a falling weight and ran over the bridge at a constant speed. The deflections were registered as it passed, and hammer-blows were produced by having in the truck a pair of geared wheels with

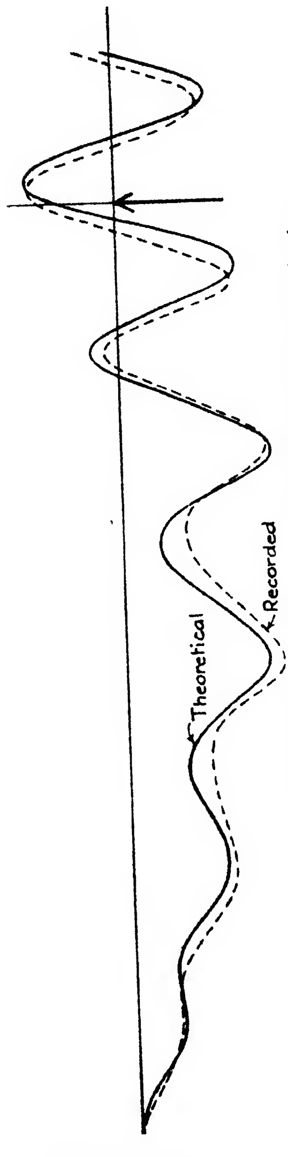

Fig. 9*.—Comparison between theory and experiment for model bridge.

revolving weights. The model was adapted to be the equivalent, on a reduced scale, of one of our actual bridges. With its help, Professor Inglis obtained extremely satisfactory confirmation of his calculations regarding the building up of the hammer-blow effects in actual bridges. Figure 9 shows a comparison

* Reproduced from the Report of the Bridge Stress Committee by kind permission of the Controller, H.M. Stationery Office.

between the observed deflection of the model bridge and the deflection as calculated from theory, taking account of damping. A coefficient of damping had, of course, to be assumed. It was only by the selection of a suitable coefficient that this close correspondence between theory and observation could be achieved.

By similar computations Professor Inglis was able to work out theoretical diagrams for the Newark Dyke Bridge under various frequencies of hammer-blow, and these showed a satisfactory agreement with the observed curves exhibited in Figure 4. One very interesting point may be mentioned. In the diagram at 2.4 periods per second, Professor Inglis' calculated curve showed less sustained vibration as the locomotive was passing off than was shown in the record of the test. Professor Inglis at once felt sure that there must be something a little wrong with that experiment. He was quite right. It turned out on closer investigation that the engine had accelerated after passing the middle of the bridge, and had run off at a speed somewhat higher than 2.4 p.p.s. By this means it kept itself in closer synchronism while the bridge changed from the loaded to the unloaded condition, and that is why the oscillations while the engine was passing off are larger than they would otherwise have been.

Passing over other typical records (which were shown on the screen), let us look at Figures 10, 11, and 12, which show the amplitude of oscillation with reference to the frequency of the hammer-blow. These are called frequency-amplitude diagrams. In a long bridge such a diagram takes the simple form shown in Figure 10. There is a sharp peak at the critical frequency, with a rapid falling away at frequencies which are either greater or less. That is illustrated by the results for the Newark Dyke Bridge, the span of which is

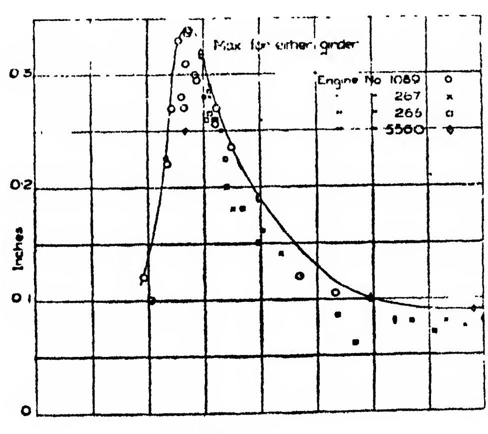

FIG. 10*.—Frequency-Amplitude Diagram for tests of Newark Dyke Bridge (Span 262½ ft.)

* Reproduced from the Report of the Bridge Stress Committee by kind permission of the Controller, H.M. Stationery Office.

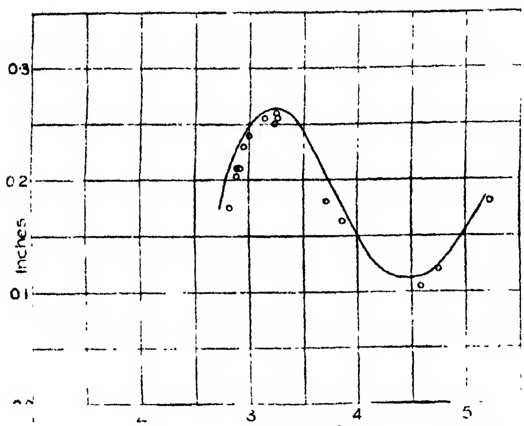

FIG. 11*. Frequency-Amplitude Diagram for tests of River Aire Bridge (Span 210 ft.)

262½ ft. There is a definite tailing off in the amplitude of oscillation up to the highest speeds included in the trials.

But when we turn to a somewhat shorter bridge we find that at high speeds there is a tendency for the amplitude to begin rising again. This is well illustrated by Figure 11, which relates to a bridge of 210 ft. span over the River Aire. You see that after passing the critical speed, and going down to a comparatively small amount, the oscillation begins again to increase very distinctly, although even at express speeds it does not increase so much as to exceed the amplitude it showed at the critical speed. It was found that this effect was exhibited more by some locomotives than by others. One of the most puzzling things with which we had to deal was to get at the true inwardness of this tendency on the part of the oscillation to rise at high speeds, long after the critical speed had been passed.

A much more marked effect of the same kind is found when you test a shorter bridge. In Figure 12 we have frequency-amplitude curves for a bridge at Langport East of 112 ft. span, showing effects with different types of locomotives. Here there are still some traces of an early critical point, but after that has been passed and the speed has got a good deal faster the oscillation continues to develop and gets bigger and bigger, so that at the highest speeds it very much exceeds that which was experienced at the critical point. You will see in these diagrams that the biggest effects are found at the highest speeds, although at an earlier stage there has been something in the nature of a critical point, especially with locomotive K. There is at least a well-developed shoulder before the final rise of amplitude begins. How is that characteristic produced? This is a problem which Professor Inglis solved by his mathematical discussion of the matter. He found it was due to the influence of the locomotive springs,

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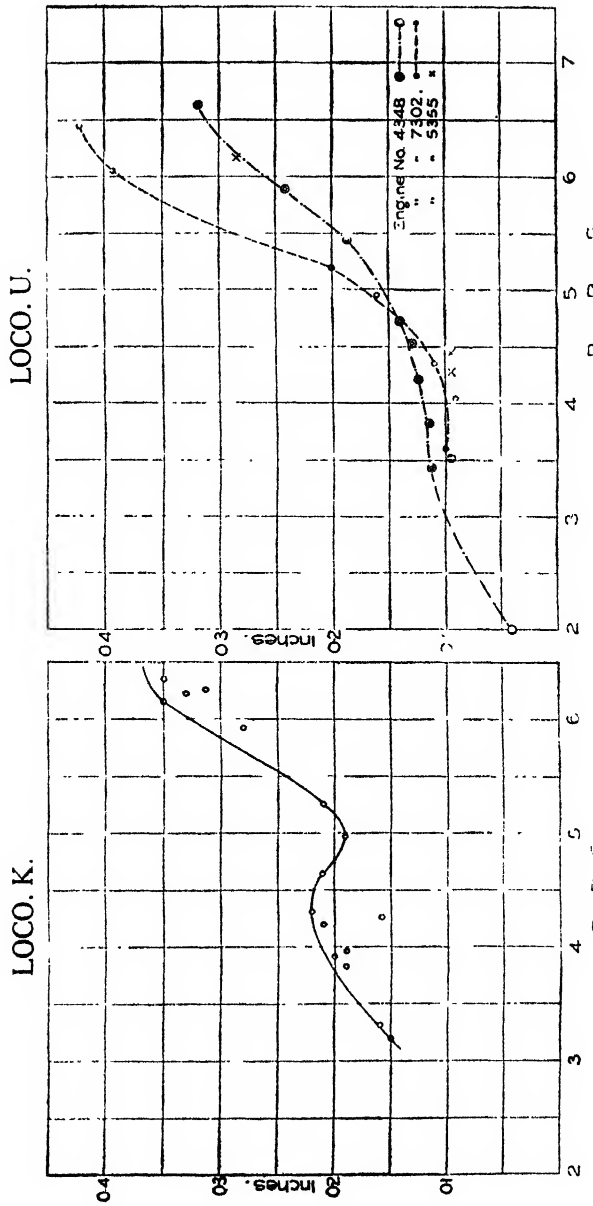
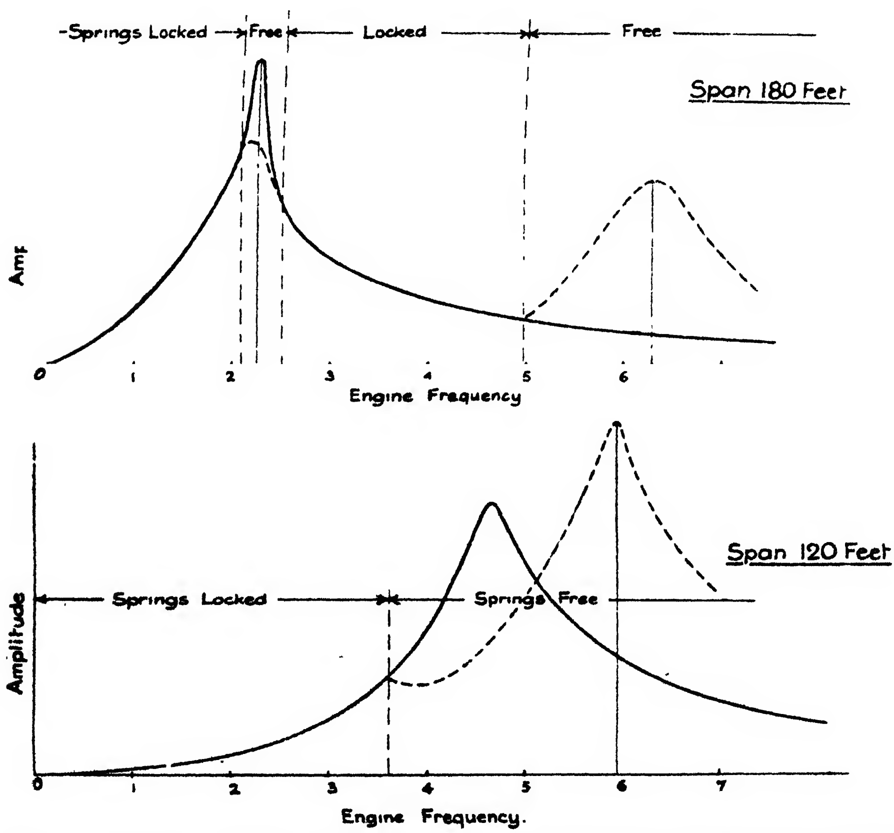


FIG. 12.*—Frequency-Amplitude Diagram for tests of Langport East Bridge (Span 112 ft.).

that is to say, to the development of mobility within the locomotive itself when its springs came into play. At low speeds the locomotive is moving as a whole. The springs are not in action; but, as the speed increases, they come into action. That is the essential cause of the further rise in amplitude of oscillation. The difference in effect between one locomotive and another is

that in one the springs are stiffer and only come into action when the oscillations become more violent.

Figures 13 and 14 will make the reason plain. They are theoretical diagrams worked out by Professor Inglis, and they illustrate his theory of what happens when the springs of the locomotive become unlocked. In both of these figures the full line shows what would happen if the locomotive springs were to remain locked, and the broken lines show what happens when the springs come into action. He takes in Figure 13 an imaginary bridge of about 180 ft. span and uses the coefficients which we had determined by means of our experiments



FIGS. 13 and 14.*—Effects of locomotive spring movement on Frequency-Amplitude Diagrams, in bridges of different spans, as calculated by Professor Inglis' theory.

with such a bridge. He finds that if the locomotive springs were to remain completely locked you would get the high peak exhibited by the full line of the diagram—the early critical point. The springs may become unlocked at

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this stage, which gives to the peak a lower height indicated by a broken line, but as the speed rises and the oscillation becomes less, the springs become locked again, and remain locked until a much higher speed is reached. In Figure 13 the peak occurs at a frequency of about 2¼: the springs become locked again at about 2½ and remain locked until the frequency rises to 5 or so. Then the springs become again unlocked and remain unlocked, and that is the cause of the subsequent rise which, in this example, gives a second critical point when the frequency is a little over 6, as is shown by the broken line. In this example, the second critical point gives an amplitude rather lower than the first. But with the shorter bridge shown in Figure 14, where the span is about 120 ft., you will observe that the locomotive springs become unlocked at a frequency of about 3.6 and remain unlocked, thereby causing the amplitude of oscillation to vary in the manner shown by the broken curve, with the result that the greatest oscillation occurs at a frequency of 6, after passing a definite shoulder in the region between 3 and 4. That is exactly the kind of action which we had observed in the Langport East Bridge (Figure 12). Thus it is seen that when the unlocking of the locomotive springs is taken into account, a complete theoretical explanation is obtained of the very complicated and puzzling effects which had been observed in our trials of actual bridges. I have dwelt on this point because it is the most distinctive contribution to engineering theory which we have been able to make, and it is of fundamental importance in determining the proper value of impact allowances. The credit for it is due to Professor Inglis.

In this way we have been able to solve the problem of the hammer-blow. It has been a long and complicated business; much more complicated than we anticipated when we began the enquiry. The general principles being established, it was comparatively easy, although it took a good while, to work out the maximum amount of impact effect which should be allowed for when the amount of loading and the amount of hammer-blow are specified. You will find Professor Inglis' theory set out in mathematical form in the Report, along with an Appendix which shows how the calculations are made, and in the body of the Report tables are given of numerical results applicable to English railways.

Besides the hammer-blow effects there are one or two minor features of impact which require to be taken into account. First there is the action of rail-joints. On a short bridge it is possible to avoid rail-joints, and it is very desirable that they should be avoided, because they may give a supplementary kind of impact which has to be added to the effect of the hammer-blow. As a general result of our experiments we give a simple rule for the addition which it is proper to make in order to provide for the rail-joint effect. This allowance is extended to include the effect of accidental irregularities in the track.

Then there is another minor impact effect which a locomotive is liable to produce through its tendency to what we call "lurching." This means a

tendency to oscillate about a horizontal fore-and-aft axis, which has the effect of throwing upon each rail alternately a larger share of the load than the half which each rail should bear. We have estimated an additional allowance to provide for that, and in this way, the total allowance is reached which, in our opinion, provides adequately for impact.

For the purpose of railway bridge design it is usual to state the loads which a bridge has to carry in terms of what is called the "equivalent uniformly distributed load." Similarly, the aggregate effects of impact may be expressed also as an equivalent uniformly distributed load. This may seem a little odd, but when you come to think of it, it is natural enough. While a loaded train is passing, the bridge, however severely it is oscillating, has at any instant a particular curvature due in part to the weight of the loads, and in part to the impact effects. You could imagine the bridge standing still with just that curvature, if you think of the instantaneous substitution of a suitably distributed load for the actual passing load. The distributed load so imagined would be acting statically, but it would hold the bridge in the state of maximum deflection which actually occurs during the passage of the train. Now the form in which the bridge is held deflected will be very nearly the same whether you take that imaginary load as uniformly distributed, or take it as distributed in the complex manner which would correspond to the actual loads and the actual effects of hammer-blow. The difference as regards bending moments is so trifling as to be unimportant. It is, in fact, very convenient, and not open to any objection, to substitute for the calculated impact effect an estimated uniformly distributed load. The Tables which we give in our Report state in that manner the total load to be provided for by adding the impact effects to the estimated weight of the passing load.

For the purpose of making these numerical estimates it was necessary to adopt some standard of loading. We adopted the standard laid down by the British Engineering Standards Association, which has now received the sanction of the Ministry of Transport. That standard assumes a train with two locomotives, each having four pairs of wheels in the engine and four in the tender. The unit is one ton on each axle of the engine, and three-quarters of a ton on each axle of the tender, and after the second locomotive there is supposed to be a following train in which the unit is one-tenth of a ton per foot run. How many of these units ought to be taken to represent the weight of the train which the bridge may have to carry? It appears from an examination of the weights of locomotives now in service that 17 or 18 of these units represent the maximum that occurs in actual British practice. But to provide for the heavier weights which may be reached by the use of three and four-cylinder locomotives 20 such units are specified by the Ministry of Transport. We adopt that, taking the heaviest trains as representing 20 of these units. Next comes the point: What amount of hammer-blow is to be provided for? To answer that, we collected statistics regarding the locomotives now in use. We finally

came to the conclusion that for the 20-unit trains of the future it will be quite sufficient to allow 5 tons of hammer-blow, measured at the conventional speed of 5 revolutions per second. That is for the heavy locomotives which are coming into use with three or four cylinders; but for the vast number of two-cylinder locomotives still in use, and likely to remain for a long time in use, we considered that a 16 unit loading with 12½ tons of hammer-blow should be allowed. And, further, there are some lighter engines now running which correspond to a 15 unit loading but have as high a hammer-blow as 15 tons. We call these loadings A, B, and C, respectively. Loading A is 20 units of weight with a 5-ton hammer-blow; loading B is a 16 units of weight with a 12½ ton hammer-blow; loading C is 15 units of weight with a 15 ton hammer-blow. We consider that loadings A and B should be provided for in all cases, and that loading C should also be provided for on any lines where engines with that objectionably heavy hammer-blow are still liable to run.

Then came a further question. How far is it necessary to provide for the simultaneous effects of hammer-blow in more than one engine when there is double-heading, or where trains are passing on a double-track bridge? What of the possibility that the engines may be exerting their hammer-blows with a complete agreement in phase, so that the bridge experiences the utmost possible effect? Our calculations provide for certain contingencies, which are definitely set forth in the Report. In single-track bridges which are long enough for two engines, we provide for the possibility of both engines being in phase. In double-track bridges that are long enough for one engine only, there might be two engines passing one another and agreeing in phase. In double-track bridges long enough to take two engines, you might have four on the bridge together, two on each line, but our calculations assume that of the four only two will be in phase. In other words, the excessively remote contingency of more than two being in phase at the instant when they are cooperating to produce the greatest bending moment is left to the factor of safety. On this basis Professor Inglis and his assistants calculated a series of curves exhibiting the estimated impact effect on bridges of various spans from the shortest to the longest. In figures 14 and 15 you see two examples of the results of these calculations for single-track bridges of various spans. From the shortest bridges up to 300 feet span, the curves show the total estimated load, including impact allowance, as a load which will give the same bending moment when uniformly distributed. The lower broken line on each diagram shows the purely static effect of a 20-unit loading. In the upper diagram the highest line of all is an enveloping curve which includes the largest impact effects that may be experienced under all three systems of loading, A, B, and C. Enveloping curves are required because we have to deal with bridges having various characteristics in respect of weight and rigidity. The full black line in an intermediate position is an enveloping curve which includes the greatest impact effects that would be experienced under

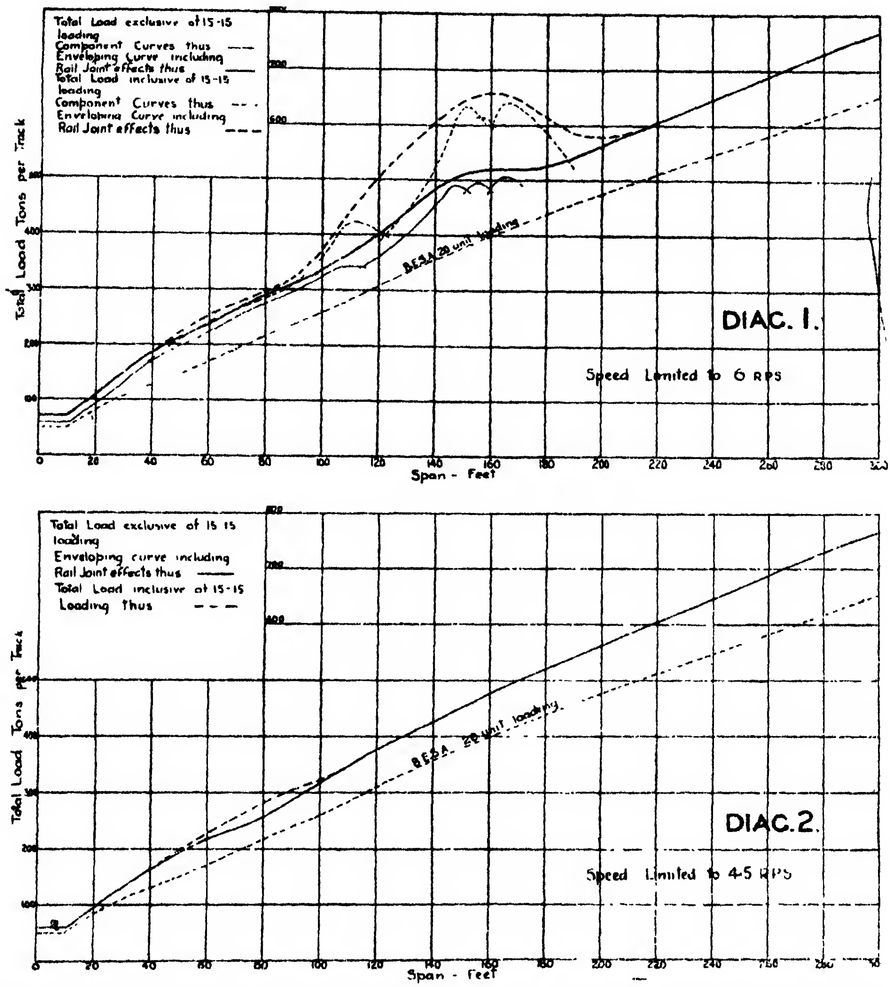

FIG. 15.—Estimated Live Loads plus Impact allowances in Single Track Bridges expressed as a uniformly distributed load.

loadings A and B, but without loading C. Note the remarkable difference between these two curves in the range of spans from 100 to 200 feet. It is in that range, as I have already said, that the worst effects of impact may be experienced in consequence of resonance. Within that range there is a very conspicuous advantage in escaping the heavy hammer-blow that is provided for in the C loading. The lower of the two diagrams in Fig. 15 illustrates how much the impact effects are reduced when, instead of providing for the express speed of 6 r.p.s., we provide only for a moderate speed of 4½ r.p.s.—a limit quite high enough to cover the case of many branch lines.

The tabulated numbers which are given in the Report for the use of engineers

are offered simply as a statement that according to our methods of calculation these are the allowances that should be provided if you have engines to deal with which possess the stated characteristics. We further set forth the methods of working out such results, so that for other railways not subject to the British limitations of gauge and loading gauge, engineers will, we hope, be able to apply the same methods to their own problems.

Perhaps I should add a word about shear. I have been speaking hitherto of the bending stresses, but we also investigated the effects of impact on the members which bear the shear, using for that purpose a group of extensometers attached to the web members. When the strains are measured in the vertical and diagonal members of a bridge, it is found that the greatest effects of impact occur at places about midway between the middle and the ends. It is there that the greatest shearing effects of impact are to be found, and theory shows that is where they are to be expected. Compared with the bending effects of impact they are not very important, but you will find tabulated values for them too in the Report.

In conclusion I would only say this: do not expect too much from the Report Do not expect to find in it any simple rules- the subject is too complex to make simple rules applicable. But I think it may claim to have rationalised the treatment of a very difficult problem. It supplies engineers with numerical results that are appropriate in ordinary cases; and, what is of more consequence, it gives them a general method of calculation which, with a little trouble, should serve in cases which lie outside of the usual range.

THE CHAIRMAN, in moving a hearty vote of thanks to the lecturer for his address, said he saw present nearly all the members of the Bridge Stress Committee, and he was sure they would agree with him when he said that after listening to the lecture they had not only been intensely interested but their minds had been clarified on a subject about which they were supposed to know something. To those, also, who had not lived with the subject for several years he was sure the lecture had proved of the greatest interest. It was no small feat to have concentrated into an hour and ten minutes the results of a work which bulked so large, and he thought there were few people who could have come through that ordeal with flying colours as Sir Alfred Ewing had done.

SIR HENRY MIERS, F.R.S., in seconding the vote of thanks, desired to add his testimony to the extraordinary skill, grace and clarity with which the lecturer had dealt with and explained so difficult a subject. It was a subject about which he could express no opinion personally, but he knew what an amount of work it had involved. For many years past he had had opportunities for watching the academic work of Sir Alfred, and it had been a wonder to him how, in the midst of his other interesting work which was involved in the carrying on of a great University, Sir Alfred had found time and energy to keep alive his interest in scientific work. From the newspapers the regrettable fact appeared that Sir Alfred intended shortly to give up his academic work. It could only be hoped that that would enable him to give more time to his scientific work, of which he had given so striking an example in the lecture that night.

The vote of thanks was carried unanimously.

THE LECTURER, in acknowledging the vote, said it was true that he had announced his intention of giving up his position as Principal of the University of Edinburgh. Such work was engrossing and immensely interesting, but it made any devotion to railway bridges and locomotives, and things of that kind, a little difficult. He hoped that he might, in the future, have a little time for old scientific interests which, to a great extent, had been put on one side for many years.

The meeting then terminated.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 6..Chemical Industry, Society of, at Burlington House, W. 8 p.m. Dr. T. Moran, "Recent Advances in the Low Temperature Preservation of Foodstuffs."

Farmers' Club, at the Whitehall Rooms, Hotel Metropole, S.W. 4 p.m. Prof. T. B. Wood, "Home-Grown Feeding Stuffs."

Geographical Society, at Lowther Lodge, Kensington Gore, S.W. 5 p.m. Dr. G. C. Simpson, "The Importance of Climatic Stations in Polar Regions."

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

Surveyors' Institution, 12, Great George Street, S.W. 8 p.m. Messrs. H. F. Bidder and W. V. Graham, "Rights in Underground Water."

Victoria Institute, at the Central Hotel, Westminster, S.W. 4.30 p.m. The Rev. Canon A. Lukyn Williams, D.D., "Early Anti-Judaica - the Book of Testimonies."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Pedro Salinas, "Thirty Years of Spanish Literature (1898-1929)." (Lecture III.)

At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. Henri Hauser, "The History of Banking in its relations with Economic and Political History during the Modern Era (XV-XVIII Centuries)." (Lecture I.)

5.30 p.m. "Some Modern Philosophies of History." (Lecture II.) Rev. Dr. W. R. Matthews, "Croce."

At University College, Gower Street, W.C. 5.30 p.m. Air Vice-Marshal J. R. Scarlett, "The Air Defence Exercises of 1928 with special reference to the Air Defence of London."

TUESDAY, MAY 7..Hellenic Studies, Society for the Promotion of, at Burlington House, W. 5 p.m. Mr. A. D. Nock, "Greek Magical Papyri."

Marine Engineers, Institute of, 85-88, The Minories, E. 6.30 p.m. Ir. W. J. Muller, "Notes on the Lentz Standard Marine Engine as fitted to Ships of the Koninklyke Paketvaart Maatschappy (Royal Packet Line), Amsterdam."

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8 p.m. Sir Oliver Lodge, "Some Ideas about Metals." (Annual May Lecture.)

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture II.)

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Prof. E. de Margerie, "Some Aspects of French Tectonics." (Lecture I.)

At University College, Gower Street, W.C. 5.30 p.m. Prof. H. T. Baker, "Geometry: a Brief Review." (Lecture II.)

WEDNESDAY, MAY 8..Fuel, Institute of, at Burlington House, W. 6 p.m. Dr. S. Wolff, "The Scope of the Chemical Engineer with special reference to the Boilerhouse and the Fuel Industries." (Joint Meeting with Institution of Chemical Engineers.)

Geological Society, Burlington House, W. 5.30 p.m.

University of London, at the London School of Economics, Houghton Street, W.C. 5 p.m. Dr. Hubert Hall, "The Nature, Value and Uses of English Judicial Records as Sources of Economic and Social Information." (Lecture II.)

THURSDAY, MAY 9..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Captain F. Tymms, "Civil Aviation Prospects in East Africa."

Antiquaries, Society of, Burlington House, W. 8.30 p.m.

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Annual General Meeting.

Historical Society, 22, Russell Square, W.C. 5 p.m. Miss Rose Graham, "Administration of the Diocese of Ely by Archbishop Winchelsey during the vacancies of the See in 1298 and 1302."

Iron and Steel Institute, at the Royal Technical College, Glasgow. 7 p.m. (1) The Hon. Sir Charles Parsons and Mr. H. M. Duncan, "A New Method for the Production of Sound Steel"; (2) Committee's Third Report on Heterogeneity of Steel Ingots; (3) Committee's First Report on Blast-Furnace Plant and Practice; (4) Mr. E. H. Lewis, "Twenty Months' Results of Dry-Blast Operation"; (5) Mr. W. F. Simons, "The A.I.B. Sinter Plant of Messrs. Guest, Keen and Nettlefolds, Ltd., Cardiff Works."

Oil and Colour Chemists' Association, at 30, Russell Square, W.C. 7.30 p.m. Mr. F. Fancutt, "Painting as it affects the Railways."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 7.30 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Pedro Salinas, "Thirty Years of Spanish Literature (1898-1929)." (Lecture IV.)

5.30 p.m. Dr. Stanley A. Cook, "The Religion of the Old Testament in its Historical Setting." (Lecture II.)

5.30 p.m. Mr. Ifor L. Evans, "Agrarian Reform in the Danubian Countries." (Lecture II.)

(King's College), at 10, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Sir Walter Scott and the Origins of the Historical Romance in Poland." (Lecture II.)

At the London School of E[illegible], Houghton Street, W.C. 5 p.m. Prof. Henri Haus[illegible], "The History of Banking in its relations with [illegible]mic and Political History during the Modern [illegible] (XV-XVIII Centuries)." (Lecture II.)

At St. Thomas's Hospital, Albert Embankment, S.E. 5 p.m. Prof. S. J. Cowell, "Dietetics." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. Prof. J. Petersen, "Faust" (in German). (Lecture II.)

FRIDAY, MAY 10..Astronomical Society, Burlington [illegible] W. 5 p.m.

Chemical Industry, Society of (Chemical Engineering Group), at the Criterion Restaurant, 221, Piccadilly, W. 6 p.m. Annual General Meeting.

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Special General Meeting.

Physical Society, at the Imperial College of Science, South Kensington, S.W. 5 p.m. 1. Dr. W. F. Sumpner, "Heaviside's Fractional Differentiator." 2. Mr. J. H. Awbery, "A Simple Method of Fitting a Straight Line to a Series of Observations." 3. Mr. E. W. H. Selwyn, "Arc Spectra in the Region λ1600-λ2100." 4. Dr. K. R. Rao, "The Spectrum of Trebly-ionised Thallium." 5. Mr. G. A. Wedgwood, "The Elastic Properties of Thick Cylindrical Shells under Internal Pressure." 6. Mr. J. E. Sears, "A Demonstration relating to Standards of Length and Mass."

Transport, Institute of, at the Midland Hotel, Manchester. 6 p.m. Annual General Meeting.

Royal Institution, 21, Albemarle Street, W. 9 p.m. Prof. Dr. E. A. Boycott, "The Twist of Snail Shells."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Henri Hauser, "The Modernity of the Sixteenth Century" (in French). (Lecture I.)

5.30 p.m. Prof. A. Mawer, "Problems of Place-Name Study in the Light of Five Years' Work of the English Place-Name Survey." (Lecture II.)

At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Prof. E. de Margerie, "Some Aspects of French Tectonics." (Lecture II.)

At University College, Gower Street, W.C. 4 p.m. Prof. Dr. A. J. Hall, "Some of the Sequels of Epidemic Encephalitis (Lethargica)." (Lecture II.)

5.30 p.m. Lektor Rolf Pande, "Norwegian Ballads." (Lecture I.)

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 3990. VOL. LXXVII.

FRIDAY, MAY 10th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

NEXT WEEK.

MONDAY, MAY 13th, at 8 p.m. (Aldred Lecture.) SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, "Nomadic Movements in Asia." (Lecture IV.)

WEDNESDAY, MAY 15th, at 8 p.m. (Ordinary Meeting.) ROBERT BURRELL, Barrister-at-Law, "The Reforming of the British Patent System." JAMES SWINBURNE, F.R.S., Past-President of the Institution of Electrical Engineers, will preside.

TWENTIETH ORDINARY MEETING.

WEDNESDAY, MAY 1st, 1929. THE RIGHT HON. LORD ASKWITH, K.C.B., K.C., D.C.L., in the Chair.

A paper on "Building Models" was read by MR. P. MORLEY HORDER, F.S.A. The paper and discussion will be published in the *Journal* dated July 12th.

ALDRED LECTURES.

MONDAY, MAY 6th, 1929. SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, delivered the third of his course of four lectures on "Nomadic Movements in Asia." The lectures will be published in the *Journal* during the summer recess.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 6TH, 1929.

MR. PERCY V. BRADSHAW, in the Chair.

THE CHAIRMAN, in introducing the lecturer, said he noticed that the Royal Society of Arts had been founded in 1754 for the encouragement of Arts, Manufactures, and Commerce—in short, for the encouragement of Mr. Tom Purvis. He doubted whether the members of the Society had ever been addressed by a man more completely associated with those three interests than the lecturer.

He felt that it was hardly necessary for him to introduce Mr. Purvis to the audience, as they had met him on many previous occasions. He had greeted them in the carriages and lifts of the Underground Railways; he had spoken to them from the hoardings, the bookstalls and many other places. He had, in his admirable Austin Reed advertising, shown discerning men what a gentleman really looked like—and what a person had to do to become one. He had, in his posters on the hoardings, sent people scuttling off to buy every kind of commodity, from a copy of *John Bull*, or a tin of desiccated soup, to a North Eastern Railway ticket. He had, in most of his designs, introduced more salesmanship than a Chairman of Directors usually achieved in the lengthiest speech, and he had reminded the man of commerce very forcibly that the artist was a most important factor in modern business. In fact, Mr. Purvis was a kind of pictorial Pooh-Bah—Arts, Manufactures and Commerce rolled into one.

Personally, he had had a life-long experience of artists—especially of illustrators and designers—and it had always been his contention that the real artists, as apart from the crank and poser, was an extraordinary logical, analytical and level-headed person, and that his originality and inventiveness would be invaluable in the solving of most business problems.

In the past only a limited side of the artist's equipment had been used. He had been regarded simply as a painter or draughtsman, and he had only been called in by commerce when a cut and dried idea had been decided upon, and a drawing was wanted. His talent should be used earlier, and much more completely. He should be consulted. not dictated to. He could be just as important and valuable as any other professional specialist, and Tom Purvis was very typical of the artist who knew his job, and did it with astounding success.

Personally he believed, as the Royal Society of Arts believed over 170 years ago, that a closer relationship between Arts, Manufactures and Commerce was vitally important. He was convinced that the hundred millions a year which were being spent on advertising British goods, could be spent much more effectively, and that advertising was not appealing as fully as it should to educated, intelligent people.

A lot of advertising was artful rather than artistic—designing rather than designed. The fine artist need not be a "mere visionary." In fact, he must not be, if he was to live. He could not resist quoting the words of a very distinguished artist, Edmund J. Sullivan, spoken in an address to students, to the effect that commerce was now taking, as Art patron, the place formerly occupied by the Church, and that there was no reason why Commercial Art to-day should degenerate into pot-boiling.

"It is not," said Sullivan, "the subject that matters, nor the patron who commissioned it. Sincerity is the thing that counts. It is not difficult, once the

fancy comes into one's head, to imagine the hoardings covered by posters, and the advertisement pages of our magazines filled with drawings, by Dürer, Holbein or Rembrandt. What detraction would there be from their Art ? What subtraction or dignity from them and their greatness ? What more can any of that great trinity have wanted by way of subject than to draw an advertisement for soap, an appeal for charity, or a portrait of the inventor of a patent medicine ? Is not one of Dürer's most moving drawings simply a pair of hands ? Let him draw for Lever Bros. Have not inventors of patent medicines faces ? Send their photograph to Holbein. Is not a beggar as moving a subject as a haloed angel ? Ring up Rembrandt. Well, then, don't let us go talking about High Art in any hoity-toity spirit. Let it be seen to that Commercial Art is not like the famous razors, only meant to sell and not to cut. If it *is* Art, it will be Art. If it is commercial first, it may not be Art afterwards, any more than a religious picture is necessarily high Art. Precision, definition, clear statement, lucidity—these are the stuff of imagination in action."

Personally he did no know any more convincing proof of imagination in action that his friend, Tom Purvis, could provide.

The following paper was then read :—

COMMERCIAL ART.

By Tom Purvis.

I approach my task with a great deal of perplexity, because the more thought I devote to it the more the realisation comes to me that the subject is far too vast for a short paper such as I am giving to-night.

Commercial art—that is, advertising art—is one of the great inter-related sections of the immense and growing profession of advertising, which itself is a logical development of the spread of commercial enterprise in the last fifty years. Commercial art itself has so many facets and ramifications that it is impossible to touch upon any but just a few main sides.

My intention is to speak on commercial art to you from the artist's point of view, and to endeavour to show you that, as a field for artists, it is not to be despised any longer, and as an adjunct to advertising enterprise it is a factor of growing importance and of vast possibilities. It seems to me that commercial art is the legitimate successor to the entirely different but equally commercial art of the Middle Ages, where artists were employed to paint pictures and decorations for the great churches—one *could* say for the purposes of religious propaganda. Then again, they were employed by the great nobles on works of art ; one *could* say, here, for *personal* propaganda.

The purely æsthetic and educational value of Art will always inspire the man who feels that it is his mission to remind the world of beauty. If one forgot that Art has its place in the world—that it ranks as an ennobling influence with music and poetry, one would have to turn the faces of Old Masters to the wall and close the World's Picture Galleries.

I do not forget the claims of Art for Art's sake, or the work of the fortunate few who are able to live by painting pictures. My belief is that Art has an even greater purpose than the merely cultural and inspirational and a more definite and vital relationship with life and progress.

I claim that Art to-day is being applied, and should be applied more definitely to human needs, and it is the type of Art which helps to develop the Nation's prosperity that I want to discuss with you.

Art for Art's sake has, I am afraid, come to be regarded more and more as a delightful luxury in this very practical age. The artist is expected to do something in addition to looking picturesque and dreaming dreams. Fewer and fewer artists are able to live by painting pictures for the drawing room wall. The World becomes increasingly impatient of theorising by " Arty Folk " and by affected studio jargon.

Art for Art's sake is an increasingly difficult text on which to preach a convincing sermon, and I feel that we commercial artists who give of our best are not only helping a very wide public to appreciate the beautiful, but we are also helping to develop an appreciation of fine design and craftsmanship.

I wish I could use Frank Brangwyn's language on the subject when it happened to be broached one day when I was on a visit to him. His words were to this purpose:

" Art must have definite usefulness in life. It is not a matter of -isms or theories. It is solid craftsmanship mixed with brains, and to survive must serve some definite purpose; that is, be *applied* to that purpose whether it be decorating a building or designing a spoon. The great day of the easel picture is waning, and art *must* be useful again as well as decorative. There is a lot too much talked and written about it and too little done; and it is only what is *done* that counts."

In his own work Frank Brangwyn looks upon himself as " a superior decorator," and I humbly but entirely agree with him on his outlook. It seems to me, apart from anything else, to be so much more healthy a point of view. No one could possibly look upon Brangwyn's work as being unhealthy in the slightest degree; although once, at an exhibition, I overheard two ladies discussing a marvellous Brangwyn decorative picture (a riot of wonderful colour), and one of them criticised it as being " so dreadfully untidy." If they had only stood back from it another twenty yards, the " untidiness " would have vanished. Brangwyn rightly does not care to exhibit his pictures in galleries. As he says, they are done for a special purpose or environment, and, outside of those surroundings, cannot be expected to give their best.

I have been constrained to mention the man I consider the greatest living artist, because he is the greatest living commercial artist and is proud of it.

Commercial art is the future field for artists, as it has been in the past, whether the artist devote himself to commercial advertising or to furniture designing or mural decoration.

Long hair and a sloppy reputation do not make an artist. It is his work that counts, and the best measure of the value of his work is its purpose in the world.

From this generalisation I am now going to particularise and speak of commercial art solely as applied to commercial advertising needs.

First and foremost let me start by asking you if you realise how an artist gets his experience and his knowledge for the application of his ability and special training to commercial purposes. Here forgive me if I explain exactly what I mean by commercial art. It is treated widely as a generic term capable of including any pictorial crime committed in the cause of commerce, particularly on the hoardings. Seriously, commercial art is the ability of the artist applied to the purposes of commerce ; that is, like furniture designing or wallpaper designing, it is an *applied* art—art applied to commercial needs. A good commercial artist must be as much a salesman as an artist. At times more of a salesman than an artist. Sad as it may seem to artists, he must *never* let his salesmanship be obliterated by his artistic sensibilities. He must have a very clear understanding of salesmanship. The final purpose of his work being to attract his audience with his message in such a way as to leave them interested in, if not actually convinced of, its entire desirability to themselves, his aim must be sure and his judgment unerring, conveying his own complete conviction of the value of his client's commodity. Advertisement designing demands imagination, invention, craftsmanship, and salesmanship.

A halo has grown round art and artists, and it is the commercial artist who has the opportunity of showing the business man that art is after all just common sense and is perfectly capable of dealing with pictorial *business* problems equally as well as, or instead of, the moral indiscretions of mythological deities or the classical features of the Mayor of Slushcombe.

The great value of art applied to commerce is being more and more widely appreciated by business men, and to my mind they are getting more keenly critical of it every day.

I think it is a dire fault that there is no completely equipped school in this country exclusively devoted to the training of students in the technique of art as applied to advertising needs, *captained by* men of actual experience and backed by business men. In many schools the commercial art classes are treated as unwanted pups. One of these days I am sure we will have schools equipped and run specially for the student of advertising art. Training at these schools would only follow after a proper orthodox art school training such as the art student undergoes now. Most students think that when they leave the art school they are finished artists—even finished *commercial* artists ! As a matter of fact, they have only been put in possession of their tools. The application of these tools would be the object of the school of commercial art that I am waiting for.

My Chairman to-night recognised, over twenty years ago, the necessity for tuition in Professional Illustration, and the Press Art School, which he established, has had a big influence on improving the standard of modern illustration.

It is to Mr. Bradshaw's very thorough and sincere Courses of Correspondence tuition that many of the most successful illustrators of to-day owe their introduction to professional careers. Well-known artists and editors have collaborated with him in the development of his work, because they realise its usefulness.

He has always been the friend of the commercial artist and illustrator. His folios of "The Art of the Illustrator" and his book "Art in Advertising" are recognised as the standard works on the subject, and he has written innumerable articles for the magazines of this country and America to help the public appreciate the best types of illustration. But one man, even if his pupils *are* distributed all over the world, can't accomplish all the work that is to be done in training the art student, and that's why I think that a very completely organised School of Commercial Art is needed.

I know there are many official schools endeavouring to help the student, to name only such well-known ones as the L.C.C. School of Printing, the Central School of Arts and Crafts, and the L.C.C. School of Engraving at Bolt Court. There must be many more, but the immense development of commercial needs in recent years, to my mind, demands some form of tuition even more allied to the needs of commercial art students. I may be wrong, but I have never heard of a school where a complete advertising campaign with all its policy and purpose is explained or in which the student is impressed with the wider aspects of the advertising man's job.

For want of such help it cost me over six years to learn something of the application of art to advertising from the inside of an advertising agency. Incidentally, my chief was one of the most enthusiastic nigger-drivers I have ever met. His enthusiasm included himself as one of the driven niggers. He was the hardest worker of the lot of us, and a brilliant advertising genius. When I felt I knew more than he did, I left—and got a shock. I found also that in my special desire to be a poster designer, I knew nothing about the practical side of lithographic printing. Back I went to a printer's, this time for roughly, two years. I believe I could design, lithograph, mix the inks necessary, do the printing and plaster the hoardings with a poster, if someone will pay the perfectly enormous fee I should ask for this unique effort. The serious side is that eight years or so were spent learning something of my business after successive art masters had washed their kindly hands of me. That is the school of commercial art I graduated from, and I should like to see some quicker and less energy-wasting method of training for students of advertising art.

Lately, I had the pleasure of reading a paper to the Publicity Club of

Bradford, and saw at the Bradford School of Art and Crafts something of the idea I have in mind being carried out under the able and energetic direction of an old art master of mine, Mr. W. H. Meggs, who very kindly showed me over the whole school during working hours. Here I really saw a splendid effort at applying art in a commonsense way to commercial needs, and it seems to me to be an exception which proves my point. Mr. Meggs' energy is greatly to be commended. His school equipment on the process reproduction side alone would make some engraving firms "sit up." It seems to me that art may have a new meaning and dignity amongst the hard-headed business men of Bradford, which is all to the great benefit of both artists and business men. One firm had commissioned the school students to repaint and decorate their motor-van, and the manager was so excited about it that he brought it round to my hotel specially to show me. It was receiving great attention wherever it happened to be, and rightly so. It was a very tasteful effort and would be bound to reflect on his business, which was the manufacture of high quality leather goods. I do think that this more intimate co-operation of business men with the art schools is an excellent step in the right direction.

I do not think that any form of publicity has the glamour surrounding it that posters have got. Princes discuss posters at banquets and even Royal Academicians now do them in their spare moments. More books have been written on the subject than on certainly any other form of advertising. Why is this? Is it that the "Poor Man's Gallery" is not his at all? Is it becoming a debating-ground of the Highbrows, or is it so universally interesting a form of appeal that even advertisement-proof highbrow demi-gods are attracted by it and to it? To my mind it is simply the appeal of the picture to the fundamental human. The first means of communication was by signs illustrating simple needs—food, shelter, defence, and so on—and the illustration has remained as being the most fundamentally interesting and the quickest means of conveying ideas.

One of the purest forms illustrating this point (I call it the Ancestor of the modern Poster) is the science of heraldry. A man or tribe was known by its own mark illustrated on its possessions. The designs of most early coats of arms are an epitome of the history of the family owning them. Some are marvellously good designs. The simplification of forms used is specially good poster form and treatment, telling its story with maximum visibility and minimum detail. I feel that a thorough study of heraldry would be useful to anyone wishing to buy posters. Some of the heraldic devices would make most admirable posters. Even the laws of colour as understood in heraldry are true colour-relation for poster visibility. I am not alone in this idea. I have heard my friend, Sir Lawrence Weaver, expound on exactly the same subject at some length and much more ably than I could possibly do it.

This mention of heraldry brings me to what to my mind is the most valuable

asset of a well-designed poster; its shock value. By shock value I mean its kick, strength, visibility, immediate readability. In this lies the poster's greatest value to the advertiser. It is the spear-head of the charge, or the shock troops of the campaign; but how many firms really show understanding of this in their choice of design. The shock value is where your artist, if he knows his job, should be left alone. Give him the indispensable elements and then leave him alone.

Which point do you want emphasizing? And here let me say that a poster, to be a real winner and give its full service, must say one thing absolutely clearly and emphatically. When you have your elements fixed, I repeat, leave your designer free to do his best. It is *his* job to analyse the material and arrange it. The measure of his skill will be the deliberate unusualness of his arrangement, based on his specialist knowledge. The freshness and shock value of the poster depend on this and this alone, even if you *are* announcing free motor cars with a pound of tea.

The artist's training in colour values alone is a very important asset to the advertiser, and the more I see of colour (and I see a lot of it), the more I realise what an enormous power it has over everything in our lives.

I once met a man who was very keen to demonstrate that it was possible so to design a succession of colour arrangements that a victim entering at one end of a series of specially decorated rooms would need a padded room in one colour only at the other end. This, in theory, sounded interesting; and I asked him to just let me peep at the design of No. 1 room of his colour arrangement. I firmly believe I should have needed the one-colour room as No. 2 arrangement if I had looked long enough.

Colour is a remarkable thing, and yet colour is just a relative term. One tone so depends on its neighbours for its beauty and life, that colour is *not* colour; it is only a bad pink or cheap-looking blue, or just green paint, until it is qualified by juxtaposition with another. Then, immediately, the inter-relation of one colour to the other makes a definite difference to the value of both, and design steps in. The possibilities of this wonderful force in the advertising profession is hardly realised yet; but it really needs a specialist to deal with it—even a specialist artist. Many very fine artists have no great mental reaction to colour as an orchestrated whole. It is a side of design which needs as much vision and composing as a musical symphony, and in your poster comes once again the enormous value of the unusual in its *colour* arrangement. But this is a subject much too great for the time at our disposal.

I would just like to add: Give your artist his head and, excepting in cases necessitating rigid economy, let him have that extra printing which he prays for sometimes and so seldom gets. Most poster artists knowing their job can even economise for their clients, help the printer at the same time, and still get the effect they want in their work.

A very valuable point in poster design is flatness of the masses of colour.

giving maximum effect, visibility and additional value to your colour by not clogging it up with dirty grey or brown half-tones and shadows.

I think that a good poster should start from the surface of the hoarding outwards and not recede into the hoarding as though the spectator was looking through a window. The surface should still look solid as if anything hitting it would bounce off instead of going through a hole. Perhaps it will explain my point better if I say there must be no hole in the hoarding caused by your poster. The finest examples of flatness and the feeling of impact are those of the Beggarstaff Brothers.

Stalwarts like the Beggarstaff Brothers opened the ball for the improvement of posters, and in their days opened the eyes of astute business men to the value of the space they bought on the hoardings. Since then, the way has been paved, and it is for their followers to improve, if possible.

Just think of the Beggarstaffs. Although the number of their posters was not large, their extraordinary insight into the possibilities of the poster, and their truly remarkable grasp of its first principles, were so astounding that they can be called the progenitors of all *modern* poster designs. Their ideas were flouted here by the timid, and they gave up the business, disappointed men. It was left to Germany to show us they were right. And some of us now look with awe on the Continental productions, not realising that the great principles of poster design were solved the first time by two of the most British men in Britain two of our finest artists still - James Pryde, whom I am proud to know personally, and William Nicholson—who, together collaborating under the nom de plume of "The Beggarstaffs," showed business men and artists the possibilities of poster design. Germany, quick to pick up ideas and develop them for her own ends, grasped the Beggarstaffs' idea of the poster, and some very fine results have been achieved there. Germany has, as I say, some very fine poster designers; but I do not see why it is necessary for our artists to bow down and worship the results as much as they seem to do. The Beggarstaff principles have proved themselves right, and now both business and art in England are recognising the value to commerce of the simple, clear, and emphatic poster. Men like Mr. W. M. Teasdale, of the L.N.E.R. (one of the most appreciative and sympathetic men it has been any artist's pleasure to work for), and my very good friend Mr. Austin Reed (I am often asked if there is *really* an "Austin Reed." There *is*; and a more genial and broad-minded man I have still to meet) these men stand out to me as shining examples of artists in commerce. There are plenty of others. Many business men I know bring more art into their commerce than some art students bring into their *art*. To my mind, these men are forerunners of a new type of business man—business men who are artists.

Many artists think, being able to draw, that they have reached the end and can sit tight for millionaires to roll up. Many commercial artists are

hoping for the day when they can cut clear from the " indignity " of commercial art and attain fame by painting a masterpiece and be courted by collectors. To my mind, this is complete fallacy. No artist who holds his best back for a future possibility is likely to hold his own. The problem of working within definite limitations is his test as an artist.

William Nicholson and James Pryde have not suffered in their subsequent work from putting all their energy into their work for the printer. Another man (in France), whose early sphere of work was the poster, is Grün. In Paris, at the Salon, a couple of years ago, I saw a most delightfully designed and painted picture, and to my astonishment it was signed " Grün," showing that he (as, I believe, also the Beggarstaffs) actually benefited in painting from experience in the poster world. Mucha was not ashamed to design posters while he also was busy on large mural decorations. Our own Frank Brangwyn delights in working to the limitations of the poster, and did so long before he was world-famous. He still keeps his eye on the hoardings, and is quite up-to-date with its happenings.

An artist's greatest asset is elasticity of mind ; and to me there is nothing like the exercise of designing a poster for a given purpose, with given limitations, and to be printed in a set economical way, for developing elasticity of mind. It is the problem that counts ; and when an artist gives up trying to solve problems, it is time for him to give up being an artist.

I do not wish you to feel that I have too great a bias on what are commonly known as art posters—those posters whose lucky job it is to express the desirability of holidays—designed mostly with joy by the artist, and looked at, perhaps, with a certain amount of disbelief, sometimes, by a public only too well aware of the existence of the English climate. I mean my remarks to be equally applied to toffee posters and baking-powder posters—all those commodities with apparently no great artistic possibility. They can all be treated with the magic of design and colour, to their good and their proprietor's profit.

One of the greatest factors militating against fine design in all branches of advertising art is the too individual personal interest of the various parties concerned. Everyone thinks he is a useful critic when it comes to the art side of a campaign. Especially is this so with posters.

Personal likes and dislikes and idiosyncrasies must be held in check The man engaged as the specialist should, of course, be expert enough and have licence enough to use or discard any points he may think harmful to the general idea or quality of the work. I did a poster once for a firm, in which orange was the dominating note, and orange was a happy colour for the particular commodity, expressing a feeling of optimism which suited it well The Board of Directors got to work on it, and the first devastating criticism I got was from one man, who said : " Personally, I dislike orange intensely. and hope we can get some other colour to take its place." They finally took

the poster with the orange. Someone might think this an example of "salesmanship"!

I always think that "too much handling spoils the poster." The only result of pleasing everyone—or rather, trying to meet everyone's criticisms, is that, in the end, the work will be so completely innocuous that no one will take notice of it at all. If it does not actually offend, it still will never arouse enthusiasm or pleasure. A bold stroke will attract attention even if it does not please everybody. And what commodity advertised is so completely universal that it will *itself* appeal to everybody?

It should be the object of the artist to utilise every atom of his ability to aim at, and hit, the precise objective of the advertiser, irrespective of even his own personal idiosyncrasies. As I have said before, commercial art is applied art.

The general trend in quality of design is very definitely upward. My experience is that there has been a steady improvement in imaginative and technical accomplishment and appreciation the whole way along. Haphazard methods of filling valuable space, and personal idiosyncrasies in selection of drawings or ideas, are slowly giving place to a well-ordered, knowledgeable selection, with a full realisation that the best space requires economical using. By economical using I do not mean the cutting down of prices and thereby cutting down quality. I mean the filling of space with idea or argument carefully calculated to convey its message efficiently without waste. Naturally, the reward of skilful work is, and should be, greater than the cost of mere haphazard methods. The economy comes in the result achieved—the "bacon that is brought home," so to speak. The expense of the haphazard method is in its failure.

The public is becoming more severely critical than many, I might say most, firms contemplating their own advertising fully realise; and I am sure I shall be supported by men of experience on this point. The best is none too good a setting for a fine jewel. A fine jewel in a poor setting suffers badly. A poor jewel in a fine setting has a much better chance of attracting. Advertising art is what one might call the public "setting" of the particular commodity, and if this "setting" is poor, haphazard, or slipshod, it instantly decreases the apparent value of the jewel.

I do not want you to think me biased on the side of posters. Newspaper advertising is so much a matter of team-work; and I consider an artist's position just that of a member of the team, equally important as your layout man, copywriter and typographer, but no more—just one of a team of experts working as a team should—each for all. The creative side of this team work is divided up between all the team, and for one to claim credit above another is as wrong as for a footballer kicking a goal thinking that his was the strategy that led to the position enabling him to kick the goal. The artist's job here is to carry out instructions, and if he thinks of an improvement, suggest it, and if it be not adopted—stay in the team.

To my mind the art of the newspaper advertising illustration has made an enormous improvement since the war. Signs of it were visible before 1914, but, looking backward, I think the real jump has come about since 1918; Possibly increased taxation has forced the necessity for the broader economy; possibly more severe competition. Possibly the hardier spirits, gifted with broader outlook, having blazed the trail and made it easy, others, now seeing profit in what they themselves first believed to be extravagance or rashness, have followed; possibly all three reasons together. Whatever the reason, the improvement is most noticeable.

In posters reason is perhaps easier to find. The poster branch of advertising is peculiarly a field of expression for artists - not that I think they do not need co-operation with other experts in the advertising profession. I have already pointed out that they do. What I mean by peculiarly the field of expression of artists is this: The artist is specially expert in pictorial representation within his own limitations of mind. His training of brain, eye and hand suits admirably the field of poster design where the spectator's attention has to be rivetted and the appeal is to be complete at a glance. Easel pictures are not easy to sell nowadays, and as the field of advertising widens it is attracting more and more talented artists who realise the enormous possibilities of poster design as a serious outlet for their efforts and as a livelihood. This all makes for improvement in quality.

Lots of advertising people still smile a little when modern art is mentioned. *I* do, at some of it. But I do think we have to thank the hardy spirits who opened up the lost or forgotten possibilities of the value of simplification of form in the expression of an idea and the tremendous value of rhythmic and ordered pattern in impressing that idea on the mind. I will try and explain. The artist once studied composition with a purely photographic eye, and endeavoured further to convey a sense of reality by meticulous and scrupulous attention to what he understood to be nature and truth. His idea was to idealise nature but to stick to her through thick and thin, endeavouring to copy her to the last detail. But the infinity of nature and the infinity of her detail defeated him, and he resolved to give an impression of her translated through his skill into paint. This was possible, and we had the schools of impressionism. Still seeking for means of clearer expression of his ideas of nature, he found that elimination of inconsequent details gave more force to the essential points; and then he found the extraordinary value and force given by the elimination were increased by marshalling the points into control with a carefully ordered pattern or rhythm harmonising with his subject, and so attained to the modern view where basic design and structural arrangement are as essential to a picture as to a building.

One of the greatest uses of the modern movements in art to advertisers is in the fillip it has given to freshness of outlook. The dramatic value of pattern has opened their eyes to an apparently new field in advertisement

design. Mind you, I'm not defending *all* modern art. Some of it is just mad striving for notoriety, and is always productive in me of the feeling engendered by my first glimpse of the design for No. 1 room in the colour arrangement for driving people mad. I am just expounding the serious development as I view it myself. An artist with any degree of brain activity cannot overlook any alley by which his work may profit, and I must say I have profited by a realisation of the modern outlook, and have applied it as capably as I could to my own problems in poster design.

The fundamental principles are applicable to every design, whether purely realistic in the popular art sense, or in the more concentrated symbolic realism in the modern art sense. The value of spacing and arrangement are just as important if the poster has a tin of salmon as its central ingredient. And here I say emphatically that a fine poster in a modern style *can* be made including a tin of salmon, and that it can still look appetising as a tin of salmon to a person who has never done anything but dodge anything looking remotely like modern art.

I think I can say that I am the first artist to get away with a poster including faces without any features on them. And the first one was this: (" Girls in Boat " poster for L.N.E.R.)

Some people believed me to be spoofing them. The effect I was aiming at was that of brilliant sunlight directed straight on to my group; and, as you all know, sunlight, if it is so bright that it hurts your eyes to look at it when you come out of a shadowy room, leaves an impression on your mind of broad masses of colour without detail; and in working out my pattern I found I had gradually and logically reduced everything to complete silhouettes in spots of colour and did not need features at all, excepting where they affected the shapes of masses.

I do not eliminate to save drawing. This poster was completely re-drawn and re-painted over half-a-dozen times. The process of elimination was gradual. Another point (and no one has ever pointed it out to me) is that the position of the boat would show the other oar clearly; but after a lot of thought I decided to leave it out, and have been justified. In the Austin Reed posters, the point to be emphasised is clothes and their proper environment: just as much detail as is necessary to express that, and nothing more.

The Shell posters are exhibited on moving petrol and oil tank lorries, and have to convey their impression faster than the lorry on the move. Everything is eliminated that would tend to fog the instant realisation of that idea as far as I possibly could.

To sum up, I should like to say this: We hear lots of talk about artists not being business men; but what I should feel grateful for, and I think commerce would benefit greatly by, would be more business men who were artists; that is to say, let us have more artistic understanding in commerce and there will be much more commerce in art. There is great need for a closer co-operation between artist and business man in England.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said that if there was any business man who had grave doubts as to the sanity of artists, and who had considered them irrational beings, full of technique and temperament, he hoped that Mr. Purvis would give him something to think about.

An important fact that the lecturer had emphasised was that Commercial Art was applied Art--that it ought to be considered from that standpoint chiefly, and on account of its suitability to its purpose. It had not only to be attractive as Art. It must sell goods or service; and that needed qualities which were not expected of the purely æsthetic types of Art.

Mr. Purvis had also emphasised the vital importance of the Commercial Artist needing a very complete technical equipment—a knowledge of reproductive processes, printing, inks, papers and materials. This knowledge could only be acquired fully by such experience as he himself had had.

Mr. Purvis had also traced, in an interesting way, the ancestry of the poster, and the value of simplification. Not only from an economic point of view, but for the purpose of delivering a message in the most direct way, simplification was essential. But the business man in a hurry had to be reminded that simplification was not an excuse for an artist to dodge work, or for the business man to dodge payment.

It was just as difficult to achieve the effect of a full colour subject, with the simple use of three or four colours, as it would be for a musician to compose a symphony with three or four notes.

He was very glad that Mr. Purvis had referred to the great influence of the Beggarstaff Brothers, for it was a little pathetic to hear German artists lauded to the skies and to find their heavy influence affecting British advertising, when one knew that they had merely adopted the methods of two essentially English artists.

Then Mr. Purvis had touched upon his favourite topic, "The Relationship between the Artist and the Business Man."

Of course he had had to refer to the artist's stock complaint, the tendency of the business man to interfere. That complaint was fully justified. He never knew how a design got on to the hoardings or into the advertisement pages of periodicals when more often than not the work had had to emerge from the criticism of a Board of Directors.

Interference by non-technical people trying to show an expert how to do his job was largely responsible for some of the very bad work seen. Advertising must of necessity imply team work, a thorough consideration of the purpose of an advertising campaign, collaboration with sales managers, copywriters and other colleagues, and the artist was only one contributor to the final result; but he should surely be left to deliver the final message to the public in what experience taught him was the most effective way.

Mr. Purvis had, of course, referred to the very latest phases of Modernistic Art, in which the artist was trying to use symbols and patterns rather than the more familiar "representational" methods. Enterprise and experiment must be encouraged in advertising, but personally he did feel that agents and advertisers were losing their heads somewhat in their violent striving for "Novelty at any Cost." They were talking to the public in a language which the vast majority of the public could not understand. Many young artists were flying to the wildest experiments in modernism because it enabled them to dodge difficult drawing. It could not be done. Eccentricity in personal salesmanship was not yet popular. Freaks and contortionists were not yet engaged by level headed business men, so as to

arrest attention and secure sales for their goods. Therefore, he could not feel that the violent rejection of all traditional methods in pictorial salesmanship was justified.

Mr. Purvis's final remarks had struck right home to him—the great importance of business men knowing something about Art, as well as artists knowing as much as possible about business. Mr. Purvis had made an appeal for closer co-operation between Art and Commerce. That was a matter of tremendous importance. He had himself written 150,000 words on the subject a couple of years ago, trying to give the most convincing evidence he could as to the value of Art in advertising, and, fired by the meeting's obvious interest in Mr. Purvis's talk, he was going home to write some more.

Mr. S. C. Rowles thought it would be interesting to hear the views of the general public, as against the views of the artist himself, with regard to the relative attractiveness of posters. For instance, Mr. Purvis had exhibited on the wall two posters, to one of which he gave a distinct preference, but the other of which he (Mr. Rowles) ventured to say would appeal most to those presons whom it was meant to attract. A great deal had been said that night about the art side and the decoration side, the appeal of distance and of colour and so on, but it was an interesting fact that at the recent exhibition at Olympia the posters which had obtained the most votes had been the naturalistic posters.

Mr. J. Ashbourne remarked that his own opinion of the Olympia Exhibition of posters was that the modernist poster had not been so well represented as had the naturalistic poster. Therefore he did not think that the ballot had been a fair test as to which of the two methods of poster advertising was the more effective.

The lecturer had referred to an ideal school of art. Personally he would like to see a school for avertisers, where advertisers could be taught to know some of the limitations and difficulties of the artist. He quoted the example of a Director of a company who had refused to accept the design of a show card containing a cerise, on the ground that he could never tolerate that colour, would not have any cerise-coloured flowers in his garden, and would not allow his wife to wear that colour.

He agreed with Mr. Purvis that an art school on the lines which he, Mr. Purvis, had suggested, would do a tremendous amount of good. Personally he had had experience of the ordinary art schools and of a professional artist's school, and he had learnt more at the latter in three months than he had learnt at the former in three years.

He thought far better advertisements would appear, and far more good designs would be sold, if it were not for the fact that many firms of printers sent round designs to their customers for which, apparently on the face of it, they did not charge. He knew a great many advertising men who would not buy a design from a recognised commercial artist because they foolishly thought that they were getting a design through their printers for nothing.

The Lecturer, in reference to Mr. Ashbourne's remarks, said he had had a good deal of experience of poster ballots, but he had never yet found that the winning poster had any degree of artistic quality at all, mainly because the people who competed started out by saying, "Which do I think is going to be first?" instead of saying, "Which do I myself like best?" Most people had no conception whatever of what a poster was designed for, what was its idea, or anything else about it. They forgot it was a telegram and not a dissertation. People did not stand about the pavement in front of a hoarding and start reading a novel; it

was the poster that "got over" in the shortest space of time, and which carried its message from the eye to the brain, and remained there, which counted.

To establish a school for advertisers would be difficult, as the people who most needed such a school would be those who were most against it, as they would think that, being the persons who paid the piper, they were entitled to call the tune, and would refuse to give their time to learning what the tune was about, or how it was played.

As to printers' free designs, any artist in the commercial art world would give a very lurid opinion on that!

Mr. F. W. Burrows said there were many people who found it fashionable after they had raised themselves to a degree of eminence which permitted of a certain loftiness of air, to turn round and abuse the schools from which they had come. He could assure those present that the art schools of this country were whole-heartedly with artists in trying to get business men interested in the matters concerned. It was difficult, however, to get business people to take the advice of artists; it was too commonly thought that artists were merely idealists.

Mr. Purvis was wrong in believing that commercial art was an unwanted thing in art schools, but if people who could not draw at all went to an art school and wanted to be made commercial artists in six months, the school would probably discourage them. He thought Mr. Bradshaw, for instance, assumed that the people who went to him had some knowledge of draughtsmanship anyhow. There were art schools which were really trying to deal with this problem, but no school would be found which would give such a complete equipment to a man as to make him an artist such as, say, Mr. Purvis. It would be asking rather too much of the art schools to expect them to do that. A person had to go into the workshop, and to mix with printers, foremen, and everyone else concerned, in order to get to know what they were thinking about. It was not quite fair to suggest that everything was wrong in the art schools.

Referring to posters, a good poster was something of an æsthetic earthquake. It had to make people look at it whether they wanted to or not. One had only to look at the pictures which decorated the walls of the Royal Society of Arts to see what he meant. Those mural decorations might be excellent works of art, but they would have no value as posters.

One man who had done a good deal to raise the poster art of England and who had not been referred to by the lecturer, was Mr. Frank Pick.

The most important paragraph of the paper was probably the last one. If those present had had nothing else read to them but that, they would have been amply repaid for the time spent there that evening.

The Lecturer said Mr. Burrows had taken him to task for talking about commercial art being an unwanted thing in art schools. In that connection he drew Mr. Burrows's attention to what he had said in the paper upon that point. If anyone asked him for advice as to which school to go to, he always suggested that they could not do better than go to the County Council evening classes to start with. He had started there himself, and he had nothing but praise for the efforts which were made there to help the student in every side of his work, but sometimes the master was not quite up-to-date in his methods. The difficulty was that there were so few teachers and so many students. The school he wanted to see established was one which would take on the student after he had finished with the orthodox art school, and give him an insight into the experience and policy which lay behind advertising schemes and agencies.

With regard to Mr. Pick, a very great deal of the improvement in posters in London, certainly on the Underground Railway, was due to the very fine influence of Mr. Frank Pick.

Mr. W. G. Raffé said he was glad the lecturer had emphasised the extreme importance of design. Art schools emphasised the importance of "drawing," until the student believed that when he could draw he could do anything; he only got to know that he had to consider design first when he obtained a job outside. The advertisers were getting busy with modernistic art. A lot of modernistic art had no meaning, and did not convey any message in connection with the goods it was supposed to advertise. Modernistic art like that was of no use, as a poster was not a work of art, but a work of advertising first and foremost. Of course it could be a work of art if it was efficient.

With regard to art schools, the Royal Society of Arts competition had shown that the art schools were being asked to do a task which they could not undertake. Most of the art masters had not had experience in commercial art, and it was not fair to ask them to turn out work which would satisfy advertising experts, nor was it to be hoped that they could produce good advertising ideas, because it took a commercial artist of considerable experience to do that. There was another point to be borne in mind. When art schools were asked to turn out commercial designers they could not do so unless they had the necessary technical equipment, and every Education Committee, especially in the small towns, could not put down the £5,000 or £6,000 necessary for that equipment.

Mr. H. G. Dowling said he differed entirely from the lecturer when he said that commercial or poster art was the legitimate successor of the mural decorations or frescos of the middle ages. A man such as Michael Angelo wrought with high ideals for men with high ideals. Again, it was hardly decent to mention the name of Rubens in connection with the names of the majority of commercial or poster artists.

Mr. Leonard C. Langley said as a printer he would like to say a word about the accusation that printers gave free sketches. As a matter of fact, several big printing houses were now employing artists of very high skill. It was a fact that printers were not always able to obtain good quality of work. They had tried to find young people who would come on and produce good work for them, but they had found it very difficult. For instance, his own firm had asked one of their young artists to get out a sketch in connection with wines, and he had produced two eighteenth century figures with green faces -which did not seem to be quite the right idea. That was a difficulty which the printers, on their side, had found.

The Lecturer, referring to a speaker's remarks about drawing, said that drawing was quite definitely the machinery of the whole thing. Drawing taught the student to use his brain, his eye and his hand. Every week he himself did at least three hours' practice at drawing.

With reference to Mr. Dowling's remarks, he quoted Mr. Herbert Furst's recent book, *The New Anecdotes of Painters and Painting*, in support of the fact that Rubens, Michael Angelo and all the old masters had definitely had a money interest in their art. "Rubens," says Mr. Furst, "was a commercial artist in the real sense of the term. He ran a factory on what might be described as mass production lines. He had a band of pupils who turned out pictures for which Rubens had

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 13.. Architects, Royal Institute of British, 9, Conduit Street, W. 8 p.m. Annual General Meeting.

East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr. A. Latifi, "A National Script for India."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. E. B. Worthington, "The Life of the Albert Nyanza and Lake Kioga."

University of London, at the London School of Economics, Houghton Street, W.C. 5.30 p.m. "Some Modern Philosophies of History." (Lecture III) Mr. R. G. Collingwood, "Spengler."
At the Royal School of Mines, South Kensington, S.W. 5.30 p.m. Prof. E. de Margerie, "Some Aspects of French Tectonics." (Lecture III)
At University College, Gower Street, W.C. 5.30 p.m. Prof. H. T. Baker, "Geometry: A Brief Review." (Lecture III)

TUESDAY, MAY 14.. Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p.m. Dr. R. F. Ashley-Montagu, "The Tarsian Hypothesis in the Descent of Man."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Annual General Meeting.

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Henry Fowler, "Motor Transport and its Importance to the Development of the Empire."

Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, S.W. 6.15 p.m. Mr. C. H. Wilson, "The International Commission on Illumination."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. G. B. Maxwell and Dr. R. V. Wheeler, "Flame Characteristics of Pinking and Non-Pinking Fuels." (Part II)

Quekett Microscopical Club, 11, Chandos Street, Cavendish Square, W. 7.30 p.m. Dr. H. A. Baylis, "Life-histories of Parasitic Worms."

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture III)

WEDNESDAY, MAY 15. Eugenics Society, at Burlington House, W. 8 p.m.

Iron and Steel Institute, at the Mappin Hall of the University, Sheffield. 2.30 p.m. (1) The Hon. Sir Charles Parsons and Mr. H. M. Duncan, "A New Method for the Production of Sound Steel." (2) Third Report of Committee on Heterogeneity of Steel Ingots. (3) Mr. G. A. Hankins and Miss G. W. Ford, "The Mechanical and Metallurgical Properties of Spring Steels as revealed by Laboratory Tests." (4) Mr. L. B. Pfeil, "The Oxidation of Iron and Steel at High Temperatures." (5) Mr. G. R. Bolsover, "Brittleness in Mild Steel." (6) Mr. H. Sutton, "The Influence of Pickling Operations on the Properties of Steel."

Literature, Royal Society of, 2, Bloomsbury Square, W.C. 4.30 p.m. General Anniversary Meeting. 5 p.m. Ordinary Meeting.

Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. (1) Messrs. J. Edmund Clark, I. D. Margary, R. Marshall and C. J. P. Cave, "Report on the Phenological Observations in the British Isles, December, 1927 to November, 1928." (2) Mr. D. Brunt, "The Index of Retraction of Damp Air, and the Optical Determination of Lapse-rate." (3) Dr. J. Reginald Ashworth, "The Influence of Smoke and Hot Gases from Factory Chimneys on Rainfall."

Microscopical Society, 20, Hanover Square, W. 7.30 p.m. (1) Messrs. E. Heron-Allen and Arthur Earland, "Some New Foraminifera from the South Atlantic.—No. 1." (2) Mr. Robert Paulson, "The Form of the Chromatophore of the Bright Green Gonidium common to many Lichens." (3) Mr. David Bryce, "On Three Cases of Encystment among Rotifers."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Henri Hauser, "The Modernity of the Sixteenth Century." (In French) (Lecture II)
At the London School of Economics, Houghton Street, W.C. 5 p.m. M. le Professeur H. Berthelemy, "The Rôle of the Conseil d'Etat in France."
5 p.m. Dr. Hubert Hall, "The Nature, Value and Uses of English Judicial Records as Sources of Economic and Social Information." (Lecture III)
At University College, Gower Street, W.C. 5.30 p.m. Lektor Rolf Paude, "Norwegian Ballads." (Lecture II)

THURSDAY, MAY 16.. Chadwick Public Lecture, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Sir Norman Walker, M.D., "The Progress of Dermatology over 50 years."

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. T. M. Lowry, "The Validity of Drude's Equation." (2) Mr. A. I. Vogel, "The Dissociation Constants of Organic Acids." Part I. "The Primary Dissociation Constants of some Alkyl Malonic Acids." (3) Messrs. T. M. Lowry and W. V. Lloyd, "The Properties of Nicotine and its Derivatives." Part I. "Molecular Extinction-Coefficients." (4) Messrs. T. M. Lowry and W. V. Lloyd, "The Properties of Nicotine and its Derivatives." Part II. "Optical Rotatory Power and Rotatory Dispersion." (5) Mr. A. I. Vogel, "The Dissociation Constants of Organic Acids." Part II. "The Primary Dissociation Constants of some Cyclic 1:1-Dicarboxylic Acids."

Electrical Engineers, Institution of, at Trinity College, Dublin. 7.45 p.m. Annual General Meeting.

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. Stanley A. Cook, "The Religion of the Old Testament in its Historical Setting." (Lecture III)
5.30 p.m. Mr. Ifor L. Evans, "Agrarian Reform in the Danubian Countries." (Lecture III)
(King's College), at 40, Torrington Square, W.C. 5.30 p.m. Dr. Julian Krzyzanowski, "Sir Walter Scott and the Origins of the Historical Romance in Poland." (Lecture III)
At the London Hospital Medical School, Whitechapel, E. 5.30 p.m. Prof. J. J. R. Macleod, "The Physiology of Glycogen." (Lecture I)
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Georg Tugendhat, "The City and the Bank of England."
At St. Thomas's Hospital, Albert Embankment, S.E. 5 p.m. Prof. S. J. Cowell, "Dietetics." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Prof. J. Petersen, "Faust." (In German). (Lecture III).

FRIDAY, MAY 17.. University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Henri Hauser, "The Modernity of the Sixteenth Century." (In French). (Lecture III).
5.30 p.m. Prof. A. Mawer, "Problems of Place-Name Study in the Light of Five Years' Work of the English Place-Name Survey." (Lecture III).
At the London Hospital Medical School, Whitechapel, E. 5.30 p.m. Prof. J. J. R. Macleod, "The Physiology of Glycogen." (Lecture II).
At University College, Gower Street, W.C. 5.30 p.m. Lektor Rolph Paude, "Norwegian Ballads." (Lecture III).

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

TWENTY-FIRST ORDINARY MEETING.

WEDNESDAY, MAY 8th, 1929 PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, in the Chair.

A paper entitled "War and the Arts" was read by MR. CHARLES J. FFOULKES, O.B.E., F.S.A., Curator of the Armouries, Tower of London. The paper and discussion will be published in the *Journal* on July 19th.

ALDRED LECTURES.

MONDAY, MAY 13th, 1929. LIEUT.-COL. SIR ARNOLD T. WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., in the Chair.

SIR E. DENISON ROSS, C.I.E., Ph.D., Professor of Persian and Director of the School of Oriental Studies, University of London, delivered the last of his course of four lectures on "Nomadic Movements in Asia." On the motion of the Chairman a vote of thanks was accorded to the lecturer for his most interesting course. The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

FRIDAY, MAY 10th, 1929. SIR E. DENISON ROSS, C.I.E., Ph.D., in the Chair.

The Sir George Birdwood Memorial Lecture was delivered by CAPTAIN P. JOHNSTON-SAINT, M.A. (Cantab.), F.R.S. (Edin.), I.A. (retd.), of the Wellcome Historical Medical Museum, his subject being "An Outline of the History of Medicine in India." The lecture will be published in the *Journal* on July 26th.

PROCEEDINGS OF THE SOCIETY.

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 13TH, 1929.

DR. WILLIAM HENRY ECCLES D.Sc., F.R.S., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said that if the Royal Society of Arts had arranged a meeting on loud speakers, say, fifteen years ago, the small audience that would have been attracted would have come mainly from those interested professionally in telephone engineering. On the present occasion there was a very big audience, which illustrated the fact that nowadays the general public knew the term "loud speaker" very much better than they had done fifteen years ago; in fact, it had now become a household phrase.

He ventured to think that the loud speaker was really only beginning its triumphs, and that as the years went on it would become a more and more familiar feature, rivalling, perhaps, in the long run the printing press itself.

He had heard many uncomplimentary remarks about loud speakers. To begin with, the very name excited prejudice. It suggested that it could never be "sweet and low." He imagined, however, that everyone present was a loud speaker lover, otherwise they would not have come. Therefore he hoped the lecturer would be kind to their favourite instrument and tell them all the pleasant things he could about it. As a matter of fact, the lecturer had studied very deeply not only the good habits, but also the vices of the instrument. Therefore it could not be expected that nothing at all derogatory would be heard about it. He hoped, however, that the audience after listening to the lecture would still be able to go away saying, "In spite of all thy faults I love thee still," or not still.

The following paper was then read:—

LOUD SPEAKERS AND THEIR DEVELOPMENT.

By R. P. G. DENMAN, M.A., A.M.I.E.E.,
of the Science Museum, South Kensington.

More than six years have elapsed since the inauguration of Broadcasting set up a world-wide demand for a powerful electrical instrument which should be capable of imitating at a moment's notice the human voice, a violin, a tinkle, a crash, a piano, a drum, or a complete orchestra. Scientifically this demand was noted at the time as a request for "a multi-frequency single-phase motor coupled to an air-pump, operating on current of frequencies varying from about 50 to 10,000 cycles per second, and voltages varying in somewhat the same ratio."[1] It is the purport of this paper to take stock of the situation as it stands to-day; to put into general circulation a few of the opinions and ideas that have been freely communicated by workers in various

[1] *I.E.E. Journal*, Vol. 62, p. 811. The statement was probably intended to apply to the "Equal Audibility" system of transmission then in fashion.

laboratories, and to suggest by demonstration and argument the extent to which some of these hopes have been fulfilled and others may still be justifiably entertained.

Because of its agreeable associations, the art of Sound Reproduction, like that of Photography, will be acknowledged to possess a twofold appeal. There are interesting theories about the latent image, or the behaviour of transients ; there are valuable metrical experiments for those who have the necessary apparatus, but above all there are always some *results* to be observed, even though they cannot always be admired. We are, for the most part, however, fortunate in the possession of eyes and ears which are willing parties to a considerable amount of deception, so long as this is not exposed too ruthlessly or too often. It may be that we have just discovered that our camera is oblivious to the existence of red and yellow, or that our 1923 pattern loud speaker is dumb from middle C downwards, yet we can still obtain some pleasure from either, until the superior merits of panchromatic film (or of the moving coil loud speaker) stand out too forcibly for us to ignore them any longer. We accustom our eyes to false colours and our ears to false tones. Knowing them to be false we accept the picture they give us as a sort of convention, and we are often sceptical at first about accepting a fresh convention, even though it approach more nearly the ideal. But however faulty its judgments, and however often it may be induced to reconsider them by logical demonstrations of error, the ear remains the deciding factor in the final verdict on any loud speaker. And since human ears and musical preferences differ greatly, there is generally some residue for discussion left over after the simplest test. It is not as if we could assemble the requirements for a perfect loud speaker in precise order of importance and then attend to them in that order. For example, assuming that many imperfections are at present inevitable, some people would say that resonances must be kept down at all costs ; others, that the chief thing to aim at is a wide range of frequency response, on the ground that resonances must abound in any room where music is played and that a few more small ones do not matter. It will, therefore, be convenient at this stage to gather together a number of more or less familiar facts which will be admitted to bear closely on the subject of sound reproduction.

Sound is a form of energy, produced by the vibrations of bodies and propagated as waves in an elastic medium, such as the air. Speech and music are organised, artificial sounds. A *pure tone* is essentially a single sinoidal vibration. Its pitch is determined by the frequency ; the intensity of the sound, as measured by some uniformly sensitive apparatus, by the air pressure that it creates. A *complex tone* is a fundamental tone with the addition of one or more overtones, again sinoidal in form. Overtones may or may not have frequencies which are exact multiples of the fundamental. Those which do so are called harmonics.

Transients are disturbances associated with changes in the amplitude of a complex tone, e.g., the beginning or the end, or else occurring as independent pulses of sound. There is much evidence[2] that the relative phases of the fundamental and the overtones in a sustained, complex tone are of no practical importance to the ear in judging its character. With regard to transients, any sound whatever could theoretically be simulated to any desired degree of perfection by the process of correctly adding together a sufficient number of pure tones, but the question whether phase is here important appears not yet to have been finally disposed of, though it seems highly probable. Mr. L. C. Pocock, who has made a preliminary study of the rather formidable mathematics of the problem in its relation to telephony, finds that a good steady-state response characteristic implies also that the response to transients is good.[3] He argues that an ideal frequency-response characteristic, linear from zero to infinity, would necessarily mean that there was no change of phase angle with frequency. And so the evident possibility, that the ear cannot obtain a true impression of a transient disturbance unless the original phases are preserved intact, need not be held to introduce any element of doubt as to the ability of such a system to respond perfectly to all sounds, for the phases would remain undistorted in any case. But since the frequency-response curves of physically realisable systems do not extend over an infinite range, there remains the question whether such curves (plus curves of amplitude) are competent to define uniquely the quality of reproduction obtainable from the system which they represent; and if the answer be yes, then whether the attainment of a perfectly flat characteristic would be accompanied automatically by freedom from phase distortion. In other words, if we take care of the frequencies, will the phases take care of themselves? Or conversely, is the introduction of phase-correcting networks a key to the obtaining of better frequency-response curves? Mr. E. K. Sandeman is of the opinion that phase distortion *can* occur in a system which has been rendered free from resonance. He has also put forward the interesting suggestion that the proper reproduction of transients requires that the system shall be responsive to all frequencies down to zero, and he is actually prepared to provide a method of radiating this latter "frequency" as a continuous air pressure, by moving the end wall or curtain of a room!

While applauding the boldness and resource of this last proposal it is important not to lose sight of Mr. Sandeman's real point, which is that the analysis of the Fourier integral corresponding to any transient pulse may

[2] See, for instance, Lloyd and Agnew, "Effects of harmonics upon acoustic quality," *Bulletin of the Bureau of Standards*, Vol. VI, p. 225, wherein Helmholtz's famous contention receives further experimental support. Phase distortion in long transmission lines due to different velocities of propagation for the different frequencies is, of course, another matter.

[3] L.C. Pocock, "Faithful Reproduction in Radio Telephony," *I.E.E. Journal*, Vol. 62, p. 804.

involve component vibrations whose periodic time is longer than that of the sustained tone with which it may happen to be associated, and that in any case they will contain one vibration of the same duration as the pulse itself This being so, it is clear that we should revise our ideas concerning the lower range of frequencies to which loud speakers should, if possible, be made to respond. These have hitherto been commonly regarded as being governed wholly by the following kind of considerations. The range of frequencies occurring in speech extends from about 60 to above 6,000, or over about seven octaves out of a total of ten comprising the entire audible range. The range of fundamental frequencies produced by sustained tones in music extends from 16 to 8,000 in organs, but this latter frequency, though it is produced by the fundamental tone of one pipe, is only used to reinforce the upper partials of other pipes. Excluding the organ, the range is from about 30 (pianoforte double bassoon, bass tuba) to nearly 4,000 (piccolo, violin). Riding on top of these fundamental tones are their overtones, giving the characteristic quality or timbre of the sound. These vary in intensity—for example, from 99.7 per cent. for the second harmonic of a fundamental piano note of frequency 512, to 1.5 per cent. for the eighth harmonic of a violin note. Above 5,000 there is a rapid dwindling of intensity in the partials of sustained musical tones, but it would be mistaken to infer from this that their psychological importance is proportionately reduced. For many persons, the squeak of a slate pencil or the note of a mosquito, however faintly heard, are capable of producing a strong emotional effect. After centuries of development, extremely high frequencies are produced by some musical instruments, and whether or not these instruments would be better without some of them, it may fairly be presumed that reproduction will be considered more or less imperfect when they are absent. The purpose of a loud speaker is presumably to reproduce sound, not to effect improvements, and to decry (on insufficient evidence) the æsthetic value of frequencies which cannot yet be reproduced is surely to make a virtue of necessity.

It has been customary to state the "ideal" upper frequency limit as 10,000, but it seems that even this is too low to secure absolute perfection. I have already stated that organ pipes having a fundamental frequency of 8,000 are regularly made. I have lately been informed by a well-known firm of organ builders that it is possible for them to distinguish differences in the tonal quality of two different kinds of these pipes. Assuming that this difference is due to the amount of second harmonic present, the "ideal" limit cannot safely be put below 16,000.

Arising out of a suggestion made by the author, the British Broadcasting Corporation recently carried out an experiment to determine the minimum percentage of second harmonic which it is necessary to superpose on a pure tone for the effect to become noticeable on an ordinary loud speaker. For this purpose an electrical generator of pure tones was employed, and it was

arranged that the output from this and from an associated frequency-doubler could be fed in measured quantities to the loud speaker. The results of the experiment are given in the following table, the first column showing the frequency of the pure tone and the second the percentage of second harmonic required to produce a noticeable change in the quality of the note emitted by the loud speaker.

Frequency of Fundamental.	Percentage of second harmonic required for audibility.
900	3
2,000	4·3
3,000	5·3
4,000	16.7
5,000	49
6,000	72.7
7,000	140

It may thus be taken as settled that if 50 per cent. of second harmonic is present in a complex tone of 5,000 cycles it will affect the ear, even after passing through a present-day loud speaker ; while the statement concerning organ-pipes shows that there are true harmonic effects (to say nothing of valuable transient components) occurring at frequencies of 10,000 and higher.

As regards practical possibilities, it is well known that neither in gramophone recording (for mechanical reasons) nor in broadcast reception (because of congested channels) does there exist at present any widespread or satisfactory source of supply for loud speakers containing frequency components much above 5,000.[4] This used to be regarded as sufficient to secure reproduction of very high quality, but as it has been definitely ascertained that the suppression of frequencies above 7,000 brings about a noticeable degradation of quality in some present-day loud speakers (none of which, however, have good efficiency in this region) it seems evident that it would be better to reserve the expression " high quality " for the proper reproduction of all frequencies up to about 8,000.

Certain peculiarities of the ear remain to be noted. Some of these conspire to make us " hear " sounds that are not physically present and to miss others that are. Experiments by A. M. Mayer[5] in 1876 drew attention to the fact that the aural sensation of even intense high tones may be obliterated or "masked" by the presence of lower tones. Hence, higher harmonics, if they do not attain a certain minimal intensity, might just as well be absent altogether, and the experiment previously cited is clearly to be regarded as

[4] This is only possible at present with an insensitive receiver situated close to a good broadcasting station. But the limitation may be removed long before loud speakers have improved sufficiently to reap the benefit.

[5] Mayer, *Phil. Mag.* 11, 500,1876. See also R. L. Wegel and C. E. Lane, *Electrical Communication*, Vol. III, p. 43 : "The auditory masking of one pure tone by another and its probable relation to the dynamics of the inner ear."

one more proof of this. It has been found, on the other hand, that when the fundamental (and even several of the harmonics) are removed from a complex tone by filtering, the ear continues to apprehend the pitch of the sound as that of the missing fundamental, though its quality does not remain unimpaired. This single fact has allowed millions of horn-type gramophones and loud speakers to come into being, which must otherwise have been found totally useless for the reproduction of music.

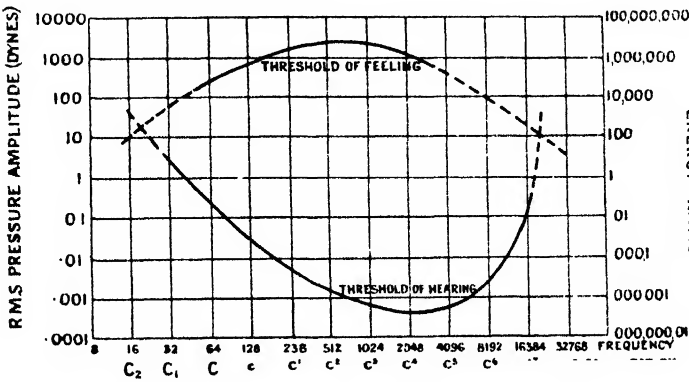

FIG. 1.—Curve showing Auditory Sensation area.

Fig. 1 shows the auditory sensitivity of the average human ear.[6] The lower curve represents the minimum sound pressure audible at different frequencies. The upper curve shows the extreme values of loudness at which the ear begins to experience the sensation of feeling rather than of hearing. The two curves enclose the area of audition. At the upper and lower limits of audition it takes about a hundred million times as much energy to enable one to hear as it does in the middle region, but the energy required is never very great, and the calculation is sometimes quoted that if a million people talked incessantly for an hour and a half they would only give out enough energy to make one cup of tea.

According to a generalisation variously styled "Weber's Law," "Fechner's Law," or the "psycho-physical law," the increase of stimulus necessary to produce an increase of sensation in any sense is not a fixed quantity, but depends upon the proportion which the increase bears to the immediately preceding stimulus. It is expressed by Fechner in the form:—The sensation increases as the logarithm of the stimulus. The law is approximately true in the case of sight, hearing, pressure and the muscular sense, but most exactly in the case of sounds of medium frequency. It follows, that just as there are sounds too weak to be heard, so there are changes in the volume of an audible sound too small to be perceived, and these changes are greater, the greater the initial loudness. This is considered by the majority of workers to justify the

[6] R. L. Jones, "The Nature of Language," *Electrical Communication*, July, 1923, p. 38.

plotting of frequency-response curves on a logarithmic basis. While agreeing that this is probably the best convention to adopt, it is due to those who oppose it to point out that Fechner's law cannot be taken as having any direct application to two sounds of different pitch. A logarithmic scale does however, have the desirable effect of making a "good" loud speaker look good, so that the harsh, uncompromising and no less arbitrary linear scale is best kept for those who are definitely on the look-out for troubles. Accordingly, it is becoming customary to chronicle the results of a loud speaker test in the form of a graph in which the abscissae are sustained musical tones, or (which is the same thing), frequencies plotted logarithmically, while the ordinates representing the energy of the sound at some chosen point are also plotted logarithmically, and often in terms of Decibels, or "Transmission Units." Two values of sound energy, P_1 and P_2, are said to differ by N Transmission Units where

$$N = 10 \log_{10} \frac{P_1}{P_2}$$

Although ½ T.U. represents about the minimum audible change in the energy of a pure tone, a sudden difference of 3 T.U. in the power radiated by a loud speaker when reproducing speech or music would not be more than just audible. This represents a change of one hundred per cent., as shown in the following table :—

Number of T.U.	Approximate Power Ratio. (Gains)
1	1.25
2	1.6
3	2
4	2.5
5	3.2
6	4
7	5
8	6
9	8
10	10
20	100
30	1000

Besides responding uniformly at all frequencies, good loud speakers must be free from amplitude distortion ; that is to say, that the energy they radiate should be strictly proportional to, and of the same frequency as the energy with which they are supplied. One would naturally expect to find that the energy from a horn or diaphragm would not be radiated evenly in all directions, and it is well known that actual frequency-response curves taken in different

positions round a loud speaker exhibit wide variations. Nor is this all. The sound pressure due to a diaphragm loud speaker (to take one example) does not obey the inverse-square law at distances greater than $\frac{D^2 f}{4500}$ feet, where D is the diameter of the diaphragm and f the frequency.[7] The position of the microphone used for taking the curves must be chosen with due regard to this and to the inevitable formation of standing waves. (This may make it desirable to swing the microphone.) These, and many other variable quantities which are known to enter into the highly complicated mathematical equation that finds expression in the frequency-response curve, have recently been most ably dealt with by L. G. Bostwick in an article entitled "Acoustic Considerations involved in Steady State Loud Speaker Measurements."[8] It is to be feared that they are such as to render all but nugatory the publication of frequency-response curves without a detailed account of the manner in which they were taken. This is obviously impossible in the present paper, where a number of such curves have been assembled from many different sources, and it would therefore be imprudent to compare any two of them, except in the most general way as regards approximate frequency range, etc. And I would add that only those who have plotted such curves can realise quite how much difference is created by a friendly (or malicious) choice of scales.

Returning after this digression, it has been noticed that, in taking response curves of gramophones, exceptionally good results are sometimes obtained, indicating that the quality of certain reproductions should be approaching perfection. In every case, however, the trained ear has rebelled at such a suggestion and has refused to be taken in under really rigorous test conditions. A possible clue to this mystery has recently been found in the Research Laboratories of the Gramophone Company. By taking particular care in their measurements they have disclosed the existence in these response curves of a fine, peaky structure, which with normal methods of measurement has been concealed by the presence of stationary waves and by the sluggishness of the apparatus used. Since these peaks are too small to have any noticeable effect upon the reproduction of steady tones, one is rather driven to conclude that their action is to degrade the reproduction of transients by unequal treatment of the different components.

It would be outside the scope of the present paper, and of its author's mathematics, to take the discussion of transients far beyond this point. But the subject does not appear to have received sufficient attention and it is hoped that further theoretical and experimental investigations may be stimu

[7] Backhaus and Trendelenburg, "The Directional Effect of Piston Diaphragms," *Zeitshrift f. Techn. Physik.*, Vol. 7, pp. 630-635, 1926.

[8] *Bell System Technical Journal*, January, 1929, p. 135.

lated by these remarks and especially also by the work of Küpfmüller[*] in the theory of transient phenomena as applied to voice-frequency telegraphs. In the meantime, it is evident that there are insufficient data to enable anyone to specify the tolerances that can be allowed to exist in the performance of a "perfect" loud speaker. All that can be said is that something short of an exact reproduction of the original binaural sound effects would probably be accepted by the ears, and, in the absence of any knowledge of deception, by the brain. But we know this already, for most people have been taken in *once or twice* by an unusually good piece of loud speaker reproduction, while I have even heard of a man offering one a cigarette. So that it becomes necessary to have recourse to methods of trial and error, and the history of loud speaker development begins in this way. But whereas the ear was at first the only judge, sound measurement and electro-acoustic theory have now reached a stage when more reliance can usually be put upon their indication than upon aural results.

Among early loud speaking devices, Edison's "Electromotograph" is usually mentioned. In this, a mica diaphragm is linked with a metal friction disc, bearing on the surface of a chalk cylinder which is kept moistened with potassium iodide or caustic potash. The telephonic currents pass from the disc to the cylinder and give rise to an increase or decrease in the force of friction between them, by virtue of the electrolytic action. The cylinder is rotated by hand and the resulting force is transmitted to the diaphragm. It is said that the device was capable of giving out speech at great intensity, but although in experiments with it at the Science Museum we have succeeded in obtaining moderately loud results and a small percentage of intelligibility, I do not think that it could have been very successful in daily operation. It is mentioned here on account of its 50-year old connection with the first telephones, and also because it made use of a principle which has been employed several times since then—the idea of a friction-relay, in which small mechanical forces control considerable local power. The same principle was adopted in the Johnsen-Rabek electrostatic loud speaker, an example of which, constructed by Mr. A. A. Campbell-Swinton, F.R.S., is also in the Museum. The last loud speaker of this class to be made was the "Frenophone," designed in 1923, by Mr. S. G. Brown, F.R.S.

More successful than the friction-relay is a device which I may call the "sluice-gate" system, to distinguish it from the "paddle" or air-pump principle utilised in the vast majority of loud speakers. Examples of this are Sir Charles Parsons' Auxetophone and Mr. Gaydon's Stentorphone, in both of which a stream of air issues from a high-pressure source through a valve controlled by the vibrations. Both these devices were originally made

[*] K. Küpfmüller, "The Building-up Processes in Wave Filters," *Elektrische Nachrichten-Technik*, 1924, Vol. 1, p. 112. See also W. Cruickshank, "Voice-Frequency Telegraphs," *I.E.E. Journal*, 1929.

as gramophones, and both gave very good results. Some small difficulty appears to have been experienced from the hissing sound of the escaping air, but it has been suggested that this problem could probably be solved in the light of more recent knowledge, by careful matching of the acoustic impedances and perhaps by introducing a low-pass acoustic filter into the system. If this were done it is possible that a very good loud speaker for public address work could be made.

Edison's need to avoid the Bell telephone patents in 1878 led him to design the chalk-cylinder receiver which I have described, and when it was found that this would speak loudly, the point was naturally emphasised. But the literature of the years which followed contains very little mention of loud-speaking telephones, for which there was naturally no very great demand. Such instruments as were made usually took the form of a Bell telephone receiver of rather larger dimensions than usual, having in particular a big diaphragm. A typical use for them was found during the War, in portable field telephone exchanges for making audible the morse buzzer call of some distant subscriber. It is not widely known that a telephone receiver much older than Bell's is in existence. This is the "Telephon" of Philip Reis, made in 1863. His transmitter was very imperfect, but his receiver, which was extremely simple, was less so. It depends upon the effect known as magnetostriction, and consists merely of a steel knitting needle, mounted on a wooden box and wound with insulated wire. The needle lengthens and contracts with the magnetising current and communicates its vibrations to the box. Quite recently G. W. Pierce has found that the effect persists even at radio frequencies, so that short metal rods can be used to replace quartz oscillators,[10] while Dr. A. P. Harrison, of H.M.S. "Vernon," has constructed a loud speaker on this principle. It is at once the oldest and perhaps the most novel of those that I shall show this evening.

Returning to the Bell telephones, it is, I suppose, probable that the addition of some sort of horn would follow without conscious invention, but it was, nevertheless, a very important step forward. The pronounced resonance of the diaphragm of a Bell telephone, when tensioned against the pull of its permanent magnet (without which all tones, if audible, would be heard an octave higher) are partially damped when the receiver is held to the ear. But if a Bell movement is used as a loud speaker this resonance is very lightly damped and the result is a weak and uneven transfer of energy to the air. By the addition of a properly proportioned sound chamber and horn the diaphragm is damped in an efficient manner, since the added load is realisable as sound energy. This stage of development—a Bell telephone movement with a short horn of conical or flared shape (which had already been reached by the gramophone in 1912)—was naturally attained very rapidly in the case of the loud speaker when a real demand was created by the inauguration of Broadcasting,

[10] *Proc. American Institute of Radio Engineers*, Jan. 1929.

and many such instruments were made. Many, indeed are still used, and it is the mournful truth that they are often a desperate remedy for a desperate disease. A typical frequency-response curve for a loud speaker of this type is shown in Fig. 2, from which it will be seen that the range of useful reproduction is from about 200 to 3,000 cycles per second, with many severe resonance peaks. For reasons of indifference, ignorance or financial stringency, as the case may be, there are at the present time thousands of obsolete wireless receiving sets so bad that almost any loud speaker is better for them than one which tells the horrid truth. By multiplying the resonances, and by partly ignoring the fictitious harmonics spued out by these shocking sets, the

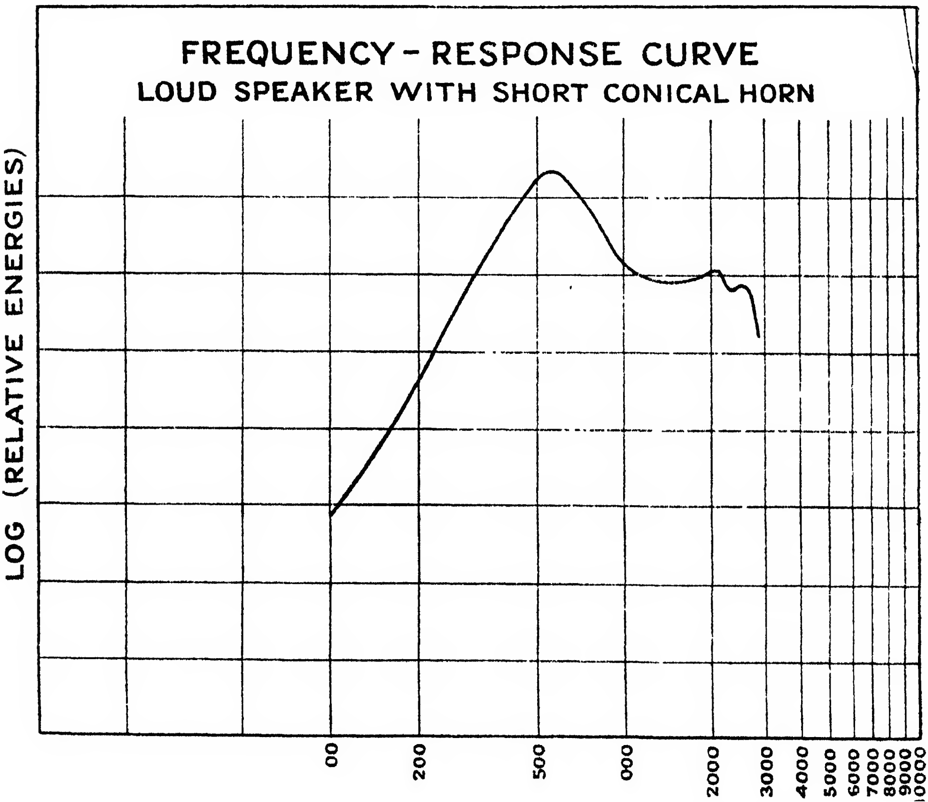

Fig. 2.—Frequency-Response Curve. Loud Speaker with short conical horn.

loud speaker of yesterday does actually perform the melancholy service of postponing its own funeral and that of its outworn associate.

It came as a surprise to most people when theory and experiment confirmed the fact that these loud speakers, in common with the gramophones of the period, were constitutionally incapable of radiating sound at any frequency below about that of middle C (256), a result which the actual experience of

listening made it difficult to credit, until attention was drawn to the friendly assistance given by the ear in reconstructing a mutilated complex tone when presented with a sufficient number of the pieces. This was hailed optimistically by some as a dispensation from further efforts towards extending the bass response of loud speakers. Others felt that something was wrong, but could not prove conclusively that the quality of the bass thus introduced by aural irregularities was actually different to that of bass notes which were really "there." Even now there are differences of opinion concerning the lower range of frequencies which it is necessary to cover in order to obtain perfection of reproduction of steady tones.

Some time ago the Bell Telephone Laboratories prepared a series of gramophone records showing the effects produced by drastic suppression of the low and high frequencies in speech and music, and by the courtesy of the Gramophone Company, I am able to reproduce them this evening. Listening to these records one is irresistibly reminded of the early phonographs and pre-war gramophones, and it must be admitted that some of the examples of high-tones loss are getting uncomfortably near home—even now.

To-day it is well known that in order to obtain good bass reproduction from loud speakers with small diaphragms, horns of great length are necessary. The advantages of a logarithmic horn, in which the cross-sectional area is an exponential function of the distance measured along the axis, were noted by A. G. Webster many years before Broadcasting commenced. Such horns were studied in detail by Hanna and Slepian, and by P. B. Flanders, and were immediately utilised for loud speakers and gramophones, to the great advantage of both. Although the length of a logarithmic horn is not a fundamental constant in the design, it is nevertheless true that the longer the horn is made the lower will be the range which a given instrument, either gramophone or loud speaker, will cover, and in practice skilful folding is necessary in order to confine the horn within the limits of even a large drawing-room cabinet. Even then the lowest note that can be satisfactorily reproduced is one having a frequency of about 90, which still leaves something to be desired, as many people can testify. A loud speaker of unusual interest will later be demonstrated in conjunction with a 15 ft. exponential horn.

Up to the present, no diaphragms or driving units have been mentioned other than the original Bell telephone. It was pointed out that the fundamental drawback of this arrangement is the fact that the diaphragm is initially stressed by the attraction of the permanent magnet, and that it must be tensioned against this force, with the result that resonances occur in conjunction with the mass of the diaphragm. The resonances could be partially suppressed by mechanical damping, but only at the expense of efficiency, which in any case is very low and of the order of 0.1 per cent., rising to about 10 per cent. for the undamped resonance.

By the avoidance of a rigid damping round the edge of the diaphragm it

is possible to drive it as a piston or plunger, and in place of many resonant frequencies there is then only one, due to the mass and stiffness of the diaphragm and its suspension. This type of diaphragm is best driven by other means and will be referred to later.

It will be evident that greater freedom of choice in the size and material of the diaphragm would result if it were not also called upon to discharge the functions of an armature, and equally, that improvements in the armature would follow if its form were not restricted to a flat circular iron disc.

In 1910 Mr. S. G. Brown patented his well-known telephone receiver, in which the flat diaphragm was replaced by a light aluminium cone, very flexibly supported round its edge, and driven from its apex by a vibrating reed armature. When the idea of separating the functions of the diaphragm and the armature was applied to a loud speaker, the problem of securing an adequate and even response at all important frequencies was still present. The reed and the small cone or diaphragm attached to it necessarily possessed separate natural frequencies; when combined there were at least two, and the designer did his best with these. Unfortunately he could not do justice to the bass, for the reed itself could not be made sufficiently flexible to enable it to respond to low frequencies without making the movement as a whole too insensitive for practical use.

About 1923 a new form of loud speaker began to appear, having a large flat or cone-shaped diaphragm of paper, driven by a light rod attached to a reed armature. One of the earliest of these loud speakers, the Lumi re, was demonstrated at the Institution of Electrical Engineers in November, 1923 The conditions were not very favourable and perhaps the instrument did not receive sufficient credit at the time. It was the first loud speaker to give an impression of bass response, and though this bass was undoubtedly largely spurious and unnatural, it was, I think, the best instrument of its period.

The next event of importance was the introduction of the Western Electric Company's cone loud speaker. This was capable of reproducing much lower tones than a horn type instrument of normal size, and its resonances in the middle and upper frequency regions were less marked, but the quality of the amplification obtainable with the average broadcast receiver was still so deplorably bad that the horn type was often preferred. The main features of the Western Electric Company's instrument were patented in 1925. The radiating system is arranged in the form of two cones joined at their bases One of the cones is truncated, leaving a large aperture at the back of the instrument. The sole support is by clamping round the edge of this aperture, so that the outer edge of the diaphragm is not fixed. The frustrum portion acts partly as a vibrator and partly as a baffle, preventing neutralisation of air pressure between back and front. The actuating mechanism was based on the Baldwin telephone movement and consisted of a magnetically balanced reed, pivoted between the extensions of a large permanent magnet, and

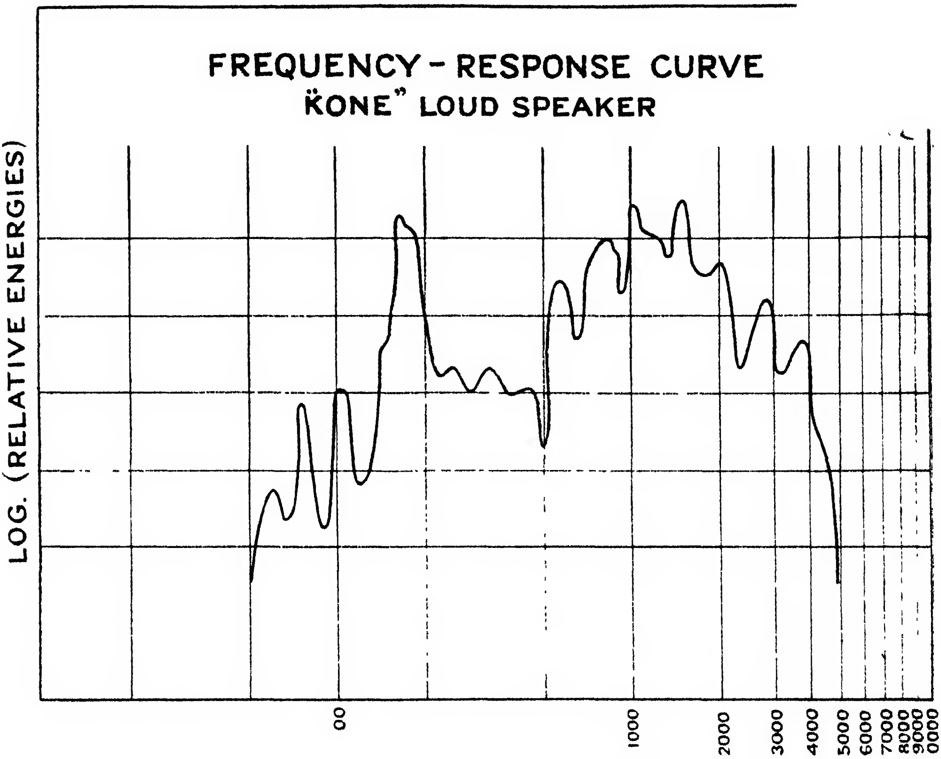

FIG. 3.—Frequency-Response Curve, "Kone" Loud Speaker.

surrounded by a small coil through which the current passed. The movement was mounted inside the hollow space of the diaphragm, and a long rod connected it to the apex of the front cone. A frequency-response curve of this loud speaker is shown in Fig. 3. This was the first instrument in which any conscious attempt was made to apply the new principle of *impedance-matching* which was then making its way into vibrational mechanics. The principle was based on G. A. Campbell's invention of the electric wave filter. It has revolutionised the gramophone and a knowledge of the principles involved is of constant value in electro-acoustics. Expressed in general terms, the theory permits of the virtual annulment of resonance effects. Any sudden change in the impedance of a mechanical or electrical system prevents the free transfer of energy across the junction. Some of it is reflected back, with the result that stationary waves are formed and resonant effects produced. By arranging the various parts of the system so that they form repeated similar sections of predetermined form it is possible to ensure that over a wide range of frequencies electrical or mechanical vibrations are transmitted with small and constant attenuation. Every section of such a filter structure considered separately, has a pronounced

resonance, but when properly terminated the system as a whole has not. Either high-pass, low-pass or band-pass filters can be constructed, and these can be designed for electrical, mechanical or acoustic vibrations, while formulæ are available for the design of mixed structures in which energy is transformed from the first of these forms into the second, and from the second to the third, without serious reflection at any point. These principles are of such great importance that some time has been devoted at the Science Museum to the construction of slow-working filter models. One of these, a mechanical band-pass filter, is now to be demonstrated.* This filter has been designed to pass vibrations of frequencies lying between 7 and 12. It nearly (but not quite) suppresses all others as the theory requires for this type.

A proper terminating resistance is essential to a filter and is very difficult to obtain mechanically. In the model an approximation to this is given by a glass cylinder with perforated end-plates, inside which a light piston is driven to and fro. Acoustically, it is given also by an infinitely long tube, and by a finite exponential horn for all frequencies above the cut-off in the lower region. The model shown has been purposely designed to have also an upper cut-off frequency, and it may serve here to demonstrate the impossibility of obtaining uniform velocity response at all frequencies in a mechanical system operating under constant force.

Before passing on to a consideration of other types of loud speaker, it is interesting to note that a new type of reed instrument has recently appeared, in which the designers have attempted to compensate for the non-linear relation between the applied force and the resultant motion (which is inherent in most reed-type instruments) by turning to account the slight flexing of the reed armature under varying magnetic attraction. So far, no experimental results (other than those which anyone may obtain by listening) are available from which it would be possible to judge the extent to which these (and other) claims are justified, but failure to secure this linear relation is common in reed-type loud speakers and is necessarily accompanied by amplitude distortion and the production of harmonics not originally present. Fig. 4 shows two response curves for this loud speaker. Curve "A" was taken in Germany; Curve "B," taken in England, is for another instrument of the same construction and it is interesting to note the extent to which they agree. But it must be emphasised that the degree of correlation between a "typical" frequency-response characteristic and the truth is no greater than that which is found to exist between the characteristics of any two specimens taken by two equally trustworthy methods.

Shortly after the introduction of the reed-driven cone came news of the development of the now well-known moving coil hornless loud speaker. The principle of this form of drive had been used as long ago as in 1894 by

* The demonstration was followed by a short slow-motion cinematograph film in which the phase-shifts in each filter section could be followed.

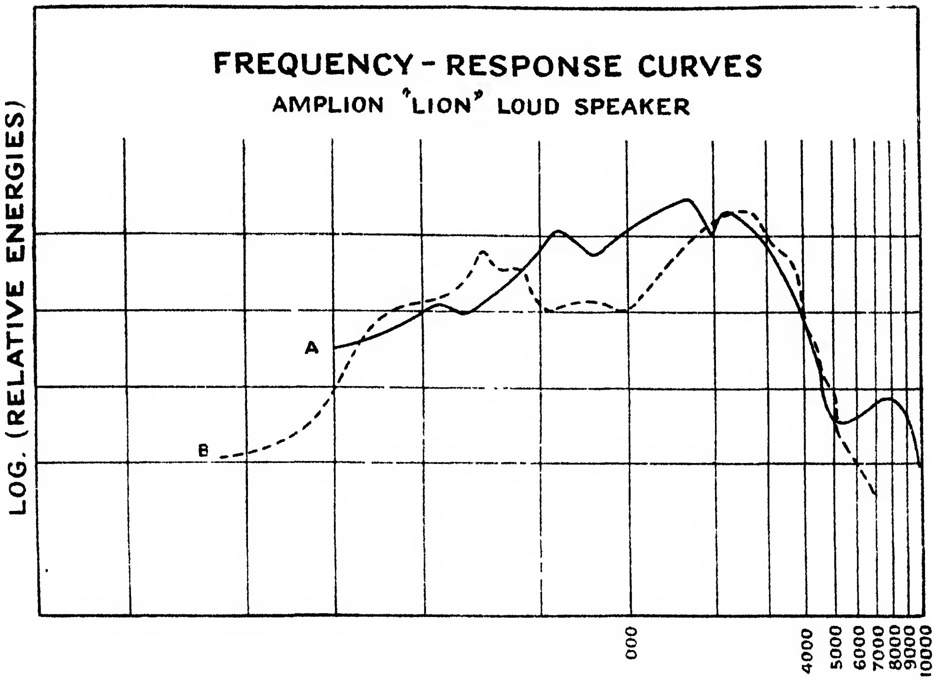

FIG. 4.—Frequency-Response Curves. Amplion "Lion" Loud Speaker.

Sir Oliver Lodge, who connected the moving coil to the diaphragm of a microphone and so caused it to actuate a second coil, connected to a further microphone. This in turn operated a third coil which carried a light wooden disc forming the loud speaker diaphragm. In this way he obtained a sensitive microphone relay for weak wireless signals transmitted by the induction method. Portions of the apparatus have been found and presented to the Science Museum by Sir Oliver Lodge and these are exhibited.

The moving coil principle possessed the outstanding advantage that the movement could be made proportional to the current over a very wide range, while large amplitudes could be obtained at low frequencies without loss of sensitivity at other frequencies. It had already been applied to the construction of horn-type loud speakers, and was again utilised by C. W. Rice and E. W. Kellogg in the design of their well-known free-edge cone loud speaker. The first approximate theory of this instrument was based on the assumption that a cone, which is freely suspended round its edge and driven by a coil at the apex, will vibrate equally and in phase at all points. The cone is surrounded by a large baffle and therefore resembles, in theory at least, the case given by Lord Rayleigh for a flat piston-like diaphragm, situated in a large rigid plane surface. Rice and Kellogg, following H. Riegger, pointed out that if a rigid conical diaphragm, small in comparison with the shortest wave-

length considered, were controlled in its movements by its inertia, and if it were driven by a constant force at all frequencies, the sound output would be independent of the frequency. As regards the requirement of rigidity, they appear to have thought that this could be maintained approximately up to a frequency of 2,000, but actually it is doubtful whether (with the material they used) the condition holds for any but the very lowest frequencies, and in some experiments by the British Thomson-Houston Company, who viewed the cone through a Rotoscope, bell-like vibrations were seen to occur at a frequency of 50 cycles. Again, the expression " small in comparison with the shortest wave-length considered " means in practice that a 6-inch cone ceases to be " small " at a frequency of 300 or less. This upsets the balance at high frequencies, but the breaking up of the diaphragm is probably a much more serious matter.

However, the actual performance of this type of loud speaker was found to be vastly superior to that of previous instruments, and especially was this true of the reproduction of low tones, as would naturally be expected from the type of drive used. Here lies the chief merit of Rice and Kellogg's work, that for the first time it became possible to produce a loud speaker of moderate size which could reproduce the bass with some approach to fidelity. A large baffle or cabinet was certainly necessary to prevent air circulation and consequent neutralisation of the low tones, but this, as well as the provision of a powerful field magnet, can generally be provided where a horn long enough to produce equivalent results would be out of the question.

The moving-coil loud speaker has been extensively studied in this country by Dr. N. W. McLachlan, The B.T.H. Company, Capt. H. J. Round, Capt. A. G. D. West, Mr. P. K. Turner, and others too numerous to mention. Dr. McLachlan was the first, and with his permission a loud speaker designed by him was made and installed at the Science Museum in 1926 for use in conjunction with a high-quality receiving set presented by the B.B.C. It is believed that the demonstrations given there daily over a period of three years, together with the enlightened action of the leading wireless journals in the publication of authoritative information, have done much to improve the standard of reproduction in this country, though it is unfortunately still true that really good results are beyond the means of many of those who are most anxious to achieve them. For domestic use a cone of six inches diameter is very satisfactory. Larger cones are more efficient, and Fig. 5 shows a frequency-response curve for a large moving coil loud speaker. The principal features of all coil-driven cone characteristics are :—(1) a low resonance, due to the diaphragm and its suspension, which should be kept as loose as other circumstances will permit ; (2) a fairly steady rise in output up to a maximum which may occur at about 3,000 cycles ; and (3) a rapid falling off in the higher frequencies. The numerous alterations which can be made in the size, material or angle of the cone, or indeed any of the variables, only affect the character-

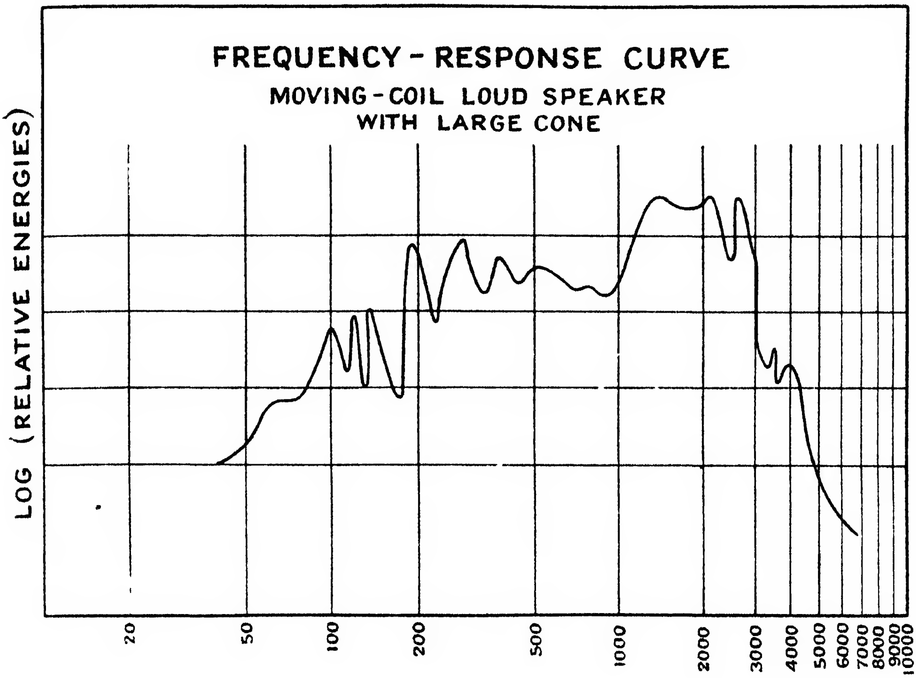

FIG. 5.

istics in a subsidiary manner, and the general form remains the same. It is therefore advantageous to introduce into the amplifying system some simple form of correction circuit, such as a resistance and condenser connected in series across the terminals of one of the anode resistances. This, if correctly chosen, will have the effect of reducing the height of the main resonance peak without affecting the response at the upper and lower extremities of the curve.

A common defect in the reproduction of these loud speakers is a tendency to give too much prominence to the bass, which then sounds "boomy." There are a number of possible causes :—

(1) The cabinet, or, in a less degree, the baffle, may resonate. The former should be a mere skeleton frame, covered with gauze, otherwise this trouble is bound to be experienced.

(2) The cone itself (in combination with its elastic support) is undoubtedly largely responsible. The reason is not quite obvious, however, for the response curves show that the resonance peak is much less severe than the main resonance around 3,000 cycles, whereas the ear is many thousand times less sensitive at the lower frequency. The radiation resistance of the cone is here, however, extremely small, and the cone, which is constantly set in motion at this frequency by transient components, will continue to vibrate with a decay

factor $\frac{R}{2M}$, where R is the total resistance and M the mass, for a long time after the initial impulse has ceased. It is probable that the ear has become accustomed to associate a slow decay period with a loud original sound, and thus receives the impression of a more pronounced resonance than actually exists.

(3) At low frequencies the amplitude of the diaphragm motion is large and there is a tendency for the restoring force to become non-linear with the amplitude. The effect of this is to produce harmonics, and these may be radiated with comparatively great efficiency, causing the ear to reconstruct a powerful subjective fundamental tone.

Thus it seems probable that the "boom" in these instruments is due to a number of contributory causes all tending the same way. It should be pointed out, however, that the loud speaker is not always entirely to blame. One of the few defects of the well-known Reisz microphone is that it over-accentuates the bass, and the trouble is likely to be less noticeable where a condenser microphone is employed. It is understood that these are now in service in certain transmissions from the London station.

Dr. N. W. McLachlan has pointed out that when the speech coil is in motion a voltage is induced in it, the effect of which may be represented by a motional impedance in series with the static impedance of the coil. In the ideal case where the coil is unrestrained, this impedance may be represented by a condenser. The effect of the supports, however, is to change the phase of the induced voltage, so that at the resonant frequency the motional impedance becomes a pure resistance. When the restoring force of the support increases rapidly with the displacement it is possible to get two or more resonant peaks in the displacement curve, and where the change is very sudden a region may be found where, for a fixed frequency, the cone can be made to vibrate with one of two different amplitudes, the change from one to the other being brought about merely by touching it.

From what has been said it will be evident that it is scarcely possible to make the suspension of a coil-driven cone as free as could be desired, and also that it is impossible to indicate any portion of its response curve where the instrument behaves strictly according to Lord Rayleigh's theory. It is, indeed, fortunate that a small paper cone can be persuaded to put up even a passable imitation of the sounds we desire to hear, and it would perhaps be unreasonable to complain if nothing better should ever be evolved for domestic use. Most of the loud speakers which remain to be noticed are at present either too large or too expensive for this purpose.

The Schlenker loud speaker, which with associated electrical reproducing apparatus has been kindly lent for demonstration by the Gramophone Company, consists of a large disc of duralumin, stretched radially nearly to its elastic limit and driven eccentrically by a moving coil of some 20 ohms impedance.

This coil is similar to that used in the Western Electric Company's Type 555 W Loud Speaker described at the end of this paper. With so large a diaphragm, partial vibration is bound to take place and the Gramophone Company have obtained some interesting sand figures, which are being shown to-night as lantern slides. The frequency-response characteristic is somewhat similar to that of the coil-driven cone, and, in addition, the acoustic output is large.

Of special interest are those loud speakers in which the force is applied evenly over the whole of the moving surface. For some reason they appear to have been rather neglected in this country, but their *a priori* merits are obvious. The electrostatic method is very suitable for the purpose, but as the sensitivity of such a speaker depends upon the polarizing voltage (and since the permanent " electret " shows no signs of leaving the laboratory stage at present), there is nothing in an electrostatic instrument to take the place of the permanent magnet in an ordinary loud speaker but a source of high potential. This was most ingeniously applied in one of Herr E. Reisz's loud speakers by transforming up, rectifying and smoothing a small proportion of the speech current itself. While visiting Berlin last summer the author had an opportunity of listening to a large Reisz electrostatic loud speaker and formed a high opinion of its capabilities. The special feature of this instrument is the diaphragm, which is of elastic material upon which is deposited a thin layer of metallic powder. Each particle behaves as an elementary diaphragm of very high natural frequency.[11]

The Statophon of Vogt-Engl-Massole was an earlier electrostatic loud speaker which has since been developed into a powerful auditorium instrument and is now used by the Tri-Ergon Company.

There are other methods of obtaining uniform vibration over a large surface. The Hewlett loud speaker employs a conducting diaphragm placed between two flat coils.[12] The speech currents are superposed on the magnetising current in these coils and induce eddy currents in the diaphragm, causing it to vibrate uniformly in the field. The power required is stated to be considerable and this is also true of the " Blatthaller " and " Falzlautsprecher," electro-dynamic instruments, all of which, however, have the same desirable feature of approximately uniform vibration over their entire radiating surfaces. Fig. 8, taken from a German publication, is a response curve of the large Blatthaller. This instrument weighs about 5 cwt. The diaphragm, of corrugated duralumin sheet, is in three sections and carries a perpendicular zig-zag winding of copper strip which lies in the gap of a 300-watt field magnet of similar shape.

Not unlike this in construction is the new (and seemingly excellent) " Riffel-falter " instrument ; but here the " winding " consists of a straight wire located in a long, narrow magnetic gap. This instrument, like the Blatthaller, is of German origin. That nation is also responsible for an experimental loud

[11] *Radio Technik und Export* (*Helios*), No. 43, 1927, p. 137.

[12] Hewlett, " A New Tone Generator," *Phys. Rev.*, Vol. 19, p. 52.

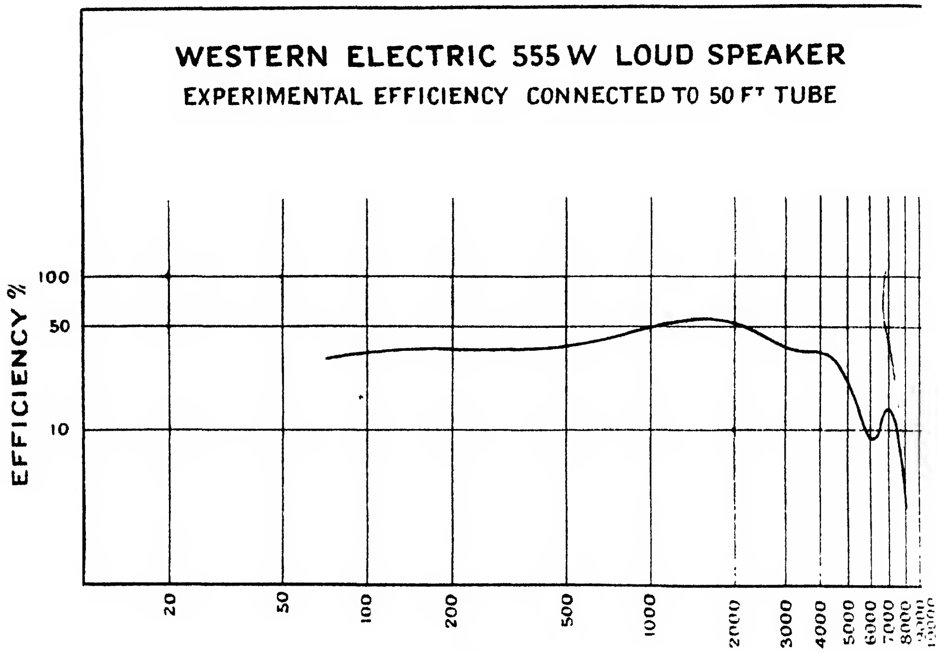

FIG. 6

speaker of great interest, for it has no moving parts as these are ordinarily understood. This glow discharge loud speaker of Breuzinger and Dessauer,[13] however, requires the application of a steady potential of 10,000 volts, and is at present of only academic interest.

The efficiency of all the loud speakers described, as measured by the ratio of the acoustic output to the electrical input, is very poor. The horn type loud speaker, however, is capable of surprising efficiency under certain conditions, as is shown by Fig. 6, which gives the efficiency of the Western Electric Company's Type 555 W Loud Speaker, designed in America by E. C. Wente and A. L. Thuras.[14] This curve was taken with the instrument connected to a 50-foot tube, and the efficiency is seen to be in the neighbourhood of 50%, which is only 3 T.U. below the theoretical maximum of 100%. This loud speaker is of the moving coil type, the coil consisting of a single layer of aluminium ribbon 0.015 inch wide and 0.002 inch thick, wound on edge and separated by a film of insulating material about 0.0002 inch thick. This type of construction has a number of advantages. It is self-supporting; ninety per cent. of the volume is occupied by metal, and heat is rapidly conducted away. The air chamber and diaphragm are shown in Fig. 7. The coil is attached edgeways to the diaphragm (a form of construction used some

[13] *Phys. Zeit.*, 29, p. 264.

[14] *Bell System Tech. Journal*, Jan., 1928, p. 140.

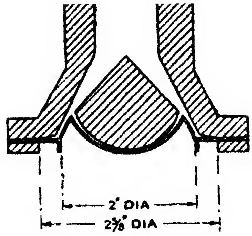

Fig. 7.—Air chamber and diaphragm of Western Electric Company's Type 555 W Loud Speaker.

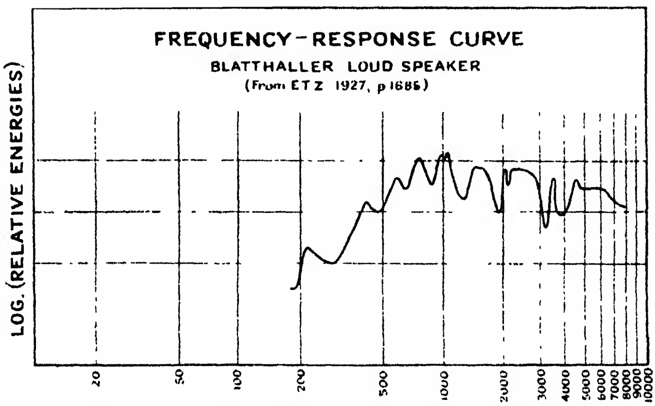

Fig. 8.

years ago by Captain Round in his coil-driven horn loud speaker). The diaphragm, which is very flexibly supported and driven plunger-fashion, is dished, and a conical obstruction placed close up to it ensures that the disturbances reach the throat of the horn approximately in phase up to high frequencies.

This loud speaker is claimed to be capable of handling about 5 watts of electrical energy with an average efficiency in practice of 30%. It is in commercial operation in this country in conjunction with the "Movietone" and "Vitaphone" talking film systems, and is to be demonstrated this evening with a 15-foot exponential horn having a calculated low-frequency cut-off at about 60 cycles.*

Bearing in mind the remarkable improvements that have been made during the six years under review, it would obviously be unwise at this stage to assume the mantle of prophecy. Science in general appears to have reached a stage at which, given the necessary funds, means can be provided to deal with almost any problem that is not fundamentally insoluble. It may be that the absence of

* During the subsequent demonstration, attention was drawn to the unusually faithful reproduction by this instrument of **crescendo** and **diminuendo** effects in music. It is thought that the failure of many loud speakers to secure this result may be due to the use of too large an input in relation to the strength of the magnetic field.

a true binaural effect constitutes one such limitation, but the imperfections of present-day materials in regard to strength, stiffness, permeability and so forth are probably more important. With the huge financial resources of the gramophone and motion-picture industries to foot the bill, it is probable that the most striking developments of the future will be made in the large auditorium instruments, and that the small domestic loud speaker will either remain in its present form or else will gradually give place to small-scale examples of these types. When one considers the size and cost of a pianoforte in relation to its average domestic usefulness, fifty pounds or so will not seem much to pay in the future for an instrument which, I dare say, will be more capable than it is at present of sustaining the many rôles that are demanded of it.

The author desires to express his very sincere thanks to the following organisations for their generous assistance in lending apparatus for demonstration :—Messrs. Standard Telephones and Cables, Ltd., the Gramophone Company, Ltd., the Chloride Electrical Storage Company, The British Thomson-Houston Company, Ltd., The Edison-Swan Electrical Co., Ltd., The M.O. Valve Co., Ltd., The General Electric Co., Ltd., and the British Broadcasting Corporation ; also to the following gentlemen for their valuable help and advice in the preparation of the paper :—Mr. J. R. Benson, Mr. H. L. Kirke, Mr. L. C. Pocock, Mr. E. K Sandeman, Mr. A. Whitaker, Capt. H. J. Round, Capt. A. G. D. West, Capt. B. S. Cohen, Mr. F. G. Davey, Mr. P. K Turner, Mr. A. G. Garton, Mr. R. E. H. Carpenter, Mr. A. P. Harrison and Mr. F. E. Godfrey. Thanks are likewise due to Col. Sir Henry Lyons, F.R.S.,for permission to exhibit objects from the Electrical Communication section of the National Science Museum.

DISCUSSION.

THE CHAIRMAN, in opening the discussion, said one point which had struck him was that in discussing loud speaker theory a great deal of attention was paid to the Fourier analysis of the motion of the diaphragm and of the air It seemed to him that too much analysis could be indulged in. Those interested could, if they liked, and perhaps they ought to, forget that the diaphragm was really an alternating current motor with a large range in frequencies and with a large range in amplitudes, and that it could be said to vibrate simultaneously with a great many frequencies, which were harmonic or not harmonic, to a fundamental. It seemed to him that they could with advantage forget a good deal of that and concentrate attention on the essence of the matter, namely, to attempt to make the diaphragm of a loud speaker move in exactly the same way as the ear-drum (which was another diaphragm) of a listener to the original orchestra. Imagine an orchestra sending out very complex waves of sound and those waves falling on the ear-drum, the ear-drum performed a very complicated motion, and if that motion could be reproduced exactly in the diaphragm of a loud speaker the waves emitted by it would have the same effect as the waves that came from the orchestra,

and there would be no need to descend to minute analysis. That was the way to look at it; it set the ideal before one and it saved thinking about the displacements in phase which no doubt took place if a loud speaker failed to operate exactly in the manner he had suggested.

The question of phase displacement had been raised in the paper. It was closely associated with the binaural sensation; that was to say, it was thought that the difference in phase of the sounds heard by the two ears was what gave a person a sense of perspective and direction acoustically. In the gramophone and in the broadcast loud speaker one had instruments which were essentially monaural; they were one-ear instruments, because when the record was being made, or when the microphone was picking up the sound waves in the studio, it acted as one ear of a listener. Therefore when the reproduction took place from the gramophone record or from the wireless receiver in the home, what was reproduced was what would be heard by a one-eared man. Although a person listened to it with two ears, it was essentially not binaural, and therefore there was a great loss in respect of perspective, perception of distance and direction, when one listened to any loud speaker.

One point which had been raised, but not elaborated, and which might be further discussed, was that in the old-fashioned loud speaker consisting of a small conical trumpet the absence of practically all notes below 300, or below middle C, was made up by the ear supplying a fundamental. The reason for that was not clearly known. Taking the fundamental as 100, this, and the harmonic 200, would be cut off because they were below 300. So that the first harmonic one heard of the collection was 300; the next was 400, and the next 500. Those notes seemed to be able to reproduce in the mind of the listener the 100, even although it was not present; and, as the lecturer had said, that had enabled a lot of loud speakers to be sold in olden days which probably would not have been sold had it not been for that dispensation of Providence.

Why did the ear supply the deficiencies? Some people said it was because difference tones were formed. The difference between the 300 and 400 was 100. That difference tone could be shown to be mathematically formed in such circumstances in the ear bones, or in the structure of the ear, or it might be that it was formed subjectively as a psychological phenomenon. But there was a difference tone between 300 and 400, between 400 and 500, and between 500 and 600—always one hundred difference; and that was perhaps sufficient to account for the whole of the phenomenon

The lecturer had referred to another point which had caused much controversy in the past and on which many different opinions were held, and that was whether music, mellowed by a gramophone horn, was or was not better than the original music, which contained, if there was a bad violin, many harsh overtones. There were many people who said that the flavour of canned salmon was much better than the flavour of a fresh Scotch salmon. Personally he could only admit that it was different! But the same theory could be applied and was applied to the subject under discussion, and he had heard it said seriously on many occasions that the mellowing effects of the horn was a thing to be desired and perpetuated. Until there had been available that latest instrument from America, he thought a great many people might have swallowed that hypothesis, but he fancied that the lecturer's demonstration of the delights of true reproduction would put an end to those imaginings.

Mr. C. G. Garton (British Thomson Houston Co.) said that strictly speaking what he had to say did not come under the heading of a contribution to the

discussion. What he hoped to do was to demonstrate an apparatus which he had present by which could be obtained actual response curves of loud speakers projected on a screen. Everyone present must have realised, when the lecturer had been performing the "squeak" experiment with various loud speakers, that it had been impossible to hold in the mind for any length of time what the response of the loud speaker had been at different frequencies. One's memory for sound was very poor, and in order to do any serious work in the way of scientific measurement on the subject, one had to have some form of apparatus which would produce the results either as a curve or as a series of readings. This, however, was a laborious task, because the curves had an enormous number of peaks and valleys, and to follow each out was a very laborious job indeed. They had led a colleague and himself to devise an apparatus which would project the curve automatically, so that it merely came to turning a handle and picking out the points on the paper.

(Mr. Garton then proceeded to describe and demonstrate the apparatus.)

At the conclusion of his demonstration Mr. Garton said he would like to refer to the question of transients, as the Chairman had made reference to phase of transients which he had applied to binaural hearing. That had not been the point which the lecturer was attempting to emphasise— and it was a point which should not be emphasised at the present stage. Leaving aside all questions of binaural hearing, the point was as follows: Supposing one had a sound which was not a musical note, but an explosive consonant like "T" that presumably consisted of one sinusoidal pulse of a certain high frequency plus a series of associated higher harmonics. The point was whether the loud speaker separated out the fundamental pulse from the others and allowed them to be emitted from the loud speaker at different times. It was quite conceivable that the harmonics might be a whole cycle in front of or behind the fundamental pulse, leaving out of question all difference of phase between two ears. Looking at transients in that way seemed to be of extreme importance, and that was one direction in which improvements were to be looked for in future loud speakers

MR. R. W. PAUL remarked that he had been requested by the lecturer to present that evening for the first time a loud speaker on which he had been working for the past few years. When he had started making moving coil instruments in 1891 it had been for a different purpose, but many of the difficulties which now arose in the case of the moving coil loud speaker had arisen in the early days of moving coil instruments for measuring purposes. He had felt that he had known nothing about telephony, so he had gone to his old friend and collaborator, Captain Cohen, at that time in the Research Department of the Post Office, and the inventor of the method just demonstrated. They had decided, after discussing the subject, that they would endeavour to approach the ideal in regard to the moving element of a loud speaker of the moving coil type. That had been expressed correctly by Lord Tomlin as a weightless, rigid, flat disc. He had present with him a loud speaker which consisted of a disc eight inches in diameter. The weight of the disc itself was ten grammes. If it was supported at the edges and loaded in the middle with a kilogramme, the deflection was a fraction of a millimetre.

(Mr. Paul then proceeded to describe the instrument in detail, and concluded by a demonstration of its powers.)

CAPT. B. S. COHEN (G.P.O.) said he desired to show a response curve for the loud speaker which had just been demonstrated. That curve was plotted on the principles laid down by Mr. Bostwick in a paper in the *Bell System Journal*. He

agreed it did soften the blow as compared with a curve purely of pressure, but one point which had not been made clear with regard to the method was that one was working to a constant base line, because the response, as defined by Bostwick, was the ratio of the acoustic power output at any point to the electrical power input as referred to a hypothetical loud speaker operated at the same point.

(Capt. Cohen then threw the curve on to the screen and explained its significance.):

One other point he would like to refer to was with regard to perfection in reproduction. That was one of the most interesting points which had been raised that evening. It appeared on first sight that a loud speaker which had a perfect frequency response over the whole audio range and freedom from non-linear distortion, might give perfect reproduction; but he was inclined to disagree with that—certainly with regard to orchestral reproductions. The reason for that, he thought, was indicated to a very great extent by what one might call the external non-linear distortion as applied to the internal non-linear distortion due to the focussing.

(Capt. Cohen then proceeded to expound the point by means of a slide on screen.)

MR. G. G. BLAKE, M.I.E.E., F.Inst.P., said there was one point in the paper in particular which he thought the man in the street had to thank the lecturer for bringing to his notice, and that was the doubtful value of frequency response curves which, as the lecturer had shown, were so open to friendly or malicious choice. Personally he considered that while frequency-response curves were of enormous value and should be studied by engineers and scientists who were seriously engaged in research work, it was far better for the man in the street simply to use his ears and be satisfied with the loud speaker which pleased him best. A person would do far better to hear a number of loud speakers and make his choice by ear, than to rely upon published curves.

The lecturer had stated that the first horn loud speaker was dated about 1910, but he (the speaker) remembered that a man named Johnson had a horn type of loud speaker in use at Shepherd's Bush as long ago as 1903 or 1904. It was, however, a very peculiar type of instrument, above its electro-magnetic poles it had the prongs of a tuning fork in lieu of a diaphragm, and it was employed in a system of "secret wireless telephony." One had to speak on one note all the time, and if one succeeded in so doing, some kind of more or less understandable reproduction could be heard from the horn of the loud speaker. It might interest the audience to know that Johnson had described and illustrated his loud speaker in a book called *Electric Flashes* (published in 1904). Johnson was, he believed, originally a teacher of music, and there were some remarkable passages in this little book. In it he described Marconi (who at that time was endeavouring to transmit across the Atlantic) as "a young man with great ambitions." In another part of the book Johnson argued "that, if one placed a wet duster between the poles of an induction coil, the current would be drawn down to it in the form of a brush discharge; therefore, how was it likely that Marconi could transmit his electric waves over the water of the Atlantic Ocean?"

MR. P. WILSON thought it might be interesting if he gave the earliest reference to a loud speaker that had ever yet been found. Siemens in 1877 had taken out a patent, No. 4685, for a loud speaking telephone which included a moving coil loud speaker of the modern type.

THE CHAIRMAN, in moving a hearty vote of thanks to the lecturer, said all present felt extremely grateful to the lecturer for the immense amount of labour and time

which he must have expended in the preparation of his paper and the demonstrations with which it had been accompanied—which demonstrations had all been excellent and successful. It was indeed hard to express in words their gratitude. There must have been, too, many negotiations with the original owners of the apparatus and also with Mr. Garton and Mr. Paul. For all that the audience thanked the lecturer. Especially did they thank him for the fact that he had managed to bring to their hearing for the first time in this country that wonderful newest triumph in the art of constructing loud speakers.

The vote of thanks was carried unanimously.

THE LECTURER, in acknowledging the vote, said he felt he was only entitled to receive a very small amount of the audience's kind applause; the rest should go to the many firms and individuals who had helped him so much.

NOTES ON BOOKS.

THE INSTALLATION OF ELECTRIC LIGHTING AND HEATING. By Frederic H. Taylor London: Chapman & Hall, Ltd. 7*s*. 6*d*. net.

This treatise, bearing evidence all through of sound practical knowledge of the subject, is divided into six sections and nineteen chapters, filling 136 pages, and includes 154 illustrations or diagrams.

In connection with rubber-covered wires, a stretching test of the rubber is advocated; conduit systems are generously dealt with and explained in detail, cab tyre and various proprietary metal-cased systems of wiring are fully discussed. also the wiring of special positions, including the use of portable gear for shipyards, docks, etc. Ceiling roses, switches and plugs are analytically brought to the notice of the reader with good advice as to selection of suitable apparatus; some further advice might perhaps be given on the protection of flexible cords at plugs which are in frequent use, and the employment of aluminium fuse wire, which is finding favour, will perhaps be given a paragraph in a future issue.

Installation work, carried out on the general principles laid down in the book, will give satisfaction for a great many years. C. A. B.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, MAY 21..University of London, at King's College, Strand, W.C. 5.30 p.m. The Most Rev. His Grace the Archbishop of Upsala, "The Church and Peace."

5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture IV).

At University College, Gower Street, W.C. 5.30 p.m. Mr. Robin Flower, "Life, History and Folklore of a Kerry Island." (Lecture I).

WEDNESDAY, MAY 22..Eugenics Society, at Burlington House, W. 8 p.m. Discussion on "Family Endowment." Speakers: Prof. D. H. McGregor, Dr. R. A. Fisher, and Prof. T. E. Gregory.

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Anathon Aall, "The Hellenistic Element in Christianity" (Lecture I).

At the London School of Economics, Ho

and Uses of English Judicial Records as Sources of Economic and Social Information." (Lecture IV).

5.30 p.m. Admiral Sir Richard Webb, "The Freedom of the Seas."

THURSDAY, MAY 23..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6 p.m. Mr. A. F. Foord, "Lubrication of Aircraft Engines."

Faraday Society, at Burlington House, W. 7.45 p.m. Annual General Meeting. Discussion on Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association).

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. Ifor L. Evans, "Agrarian Reform in the Danubian Countries." (Lecture IV).

At St. Thomas's Hospital, Albert Embankment, S.E. 5 p.m. Prof. S. J. Cowell, "Dietetics." (Lecture IV).

At University College, Gower Street, W.C. 2.30 p.m. Lecture on the Recent Discoveries of the British School of Archæology in Egypt at Beth-peleth Palestine, by Prof. Sir Flinders Petrie.

FRIDAY, MAY 24..Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. (1) Dr. Ezer Griffiths, "A Hygrometer for use in Timber Seasoning." (2) Dr. J. N. Vincent, "Experiments on Magneto-strictive Oscillations at Radio-Frequencies."

University of London, at Birkbeck College, Bream's Buildings, E.C.4. 5.30 p.m. Prof. Sten de Geer, "Sweden and the North of Europe." (Lecture I).

At King's College, Strand, W.C. 5.30 p.m. M. Denis Saurat, "André Gide."

5.30 p.m. Prof. Anathon Aall, "The Hellenistic Element in Christianity." (Lecture II).

SATURDAY, MAY 25..Victoria and Albert Museum, South Kensington, S.W. 3 p.m. Mr. Hubert Langley, "Some English Poetry."

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No. 3992. VOL. LXXVII.

FRIDAY, MAY 24th, 1929.

All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C.(2)

NOTICE.

TWENTY-SECOND ORDINARY MEETING.

WEDNESDAY, MAY 15th, 1929. MR. JAMES SWINBURNE, F.R.S., Past-President of the Institution of Electrical Engineers, in the Chair.

A paper on "The Reform of the British Patent System" was read by MR. ROBERT BURRELL, Barrister-at-Law. The paper and discussion will be published in the *Journal* dated August 2nd.

PROCEEDINGS OF THE SOCIETY

SIXTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 20TH, 1929.

LIEUT.-COL. SIR ARNOLD WILSON, K.C.I.E., C.S.I., C.M.G., D.S.O., in the Chair.

THE CHAIRMAN, at the opening of the meeting, said that Lord Stanmore, who was to have presided, was unfortunately indisposed and unable to attend. Speaking as a layman, it was his conviction that, after cookery and housekeeping, architecture was the most vital, the most vivid, the most essential and the most living of all arts and crafts. Bacon had remarked that houses were made to live in and not to look at; but he was then speaking less truly than was his wont, perhaps, because he did not realise the growth of ten-storey skyscrapers. The lecture about to be delivered was of a most novel and interesting nature and it would be accompanied by a large number of slides, some of which had never been shown before, on several forms of modern English architecture.

The following paper was then read:—

MODERN ENGLISH ARCHITECTURE.

By A. E. Richardson, F.S.A., F.R.I.B.A.,

Professor of Architecture, University of London.

Most English architects would like to see the general level of building raised. At this juncture a section of opinion inclines to the view that the past should be forgotten and all effort concentrated on the future.

You will agree that this policy is very sweeping. In the first place the future depends upon the present, and as the present is the result of the past we return to the old process of evolution. In other words, we cannot escape from the myriad incidents which form, collectively, the basis of present-day civilisation.

When we examine the progress of the arts from the earliest times we find that the cycle from the primitive to the highly cultivated has been consistent with the development of the race. Art at various epochs has worked out its destiny from the primary to the stylistic. The sum total of the world's experiments in art is style. During the passing of the centuries the old structural integrity of the arts became obscured by style. There was bound to come a time when the plastic arts would become tired. There were signs of this "tired feeling" in the 19th century, when all the arts became imitative of old styles, the truth being that Democracy was learning to participate in reminiscences of good old things. During the past quarter of a century the arts have passed to a new stage of transition. The old has not been forgotten; it has merely been modified. Professor Lethaby describes this period of transition as a search for new rulings of structure. . . . He is right. We are trying to produce efficient buildings. The danger is that we may sacrifice beauty to efficiency. Fortunately, the weight of opinion inclines to a compromise between old and new, that is to say, in so far as the treatment of material goes. The new is inevitable, but it must be evolved; it cannot be anticipated. We may think for the time being that a factory style is the solution; we may incline to a steamer style, or merely an aeroplane style; we may even invent structural-looking buildings that have nothing to recommend them but novelty. The whole thing is debatable.

For my own part, I favour the policy of *festina lente*. It would be madness to discard scholarship, and equally futile to ignore the advances made in science. English buildings of the best type combine the qualities of old work with the freshness of new ideas; therefore I propose to take these works as models of this age of transition.

Art generally works out its own solution between two extremes. There is no doubt of the fact that the Arts are steadying down to a new era of structural grace. It has been realised that thorough work lives. In architecture we do not require shibboleths and catch-phrases such as originality, modernism,

design, composition, style, etc., etc. We desire fine buildings. A formula for obtaining this result cannot be devised. How many painters could write an essay on how they purchased their own works? Lord Kelvin once asked a workman if he could explain electricity. "No, my Lord," was the reply. "Neither can I," said the great man. Inigo Jones was once commissioned to investigate the origin of Stonehenge, for which he was paid in advance. The University of Oxford commented on his failure to arrive at a result. The record reads: "Paid Mr. Inigo Jones, a great traveller, 50 pounds; he promised much and performed little." I sincerely hope that after you have heard my lecture you will be lenient with me.

My task is an explanation of the architectural tendencies of to-day. I will begin by saying that the best English buildings are very good indeed; the worst are horrid. The finest compare favourably with any modern buildings erected in any other country. They are English in character; they express insular conditions; and they are up-to-date. This result is due to the skill of the architects, to the educational policy of the Royal Institute of British Architects, and to the fact that school-trained men are beginning to practice.

Architecture is an aristocratic art; it demands a cultured view point. It depends for its success upon the supreme control of an artist. In spite of the psychic delirium of "Modernism," it has not been found possible to invent a formula for design. If we were a nation of robots we might be content to admire a machine-looking style. At this present we are untidy human beings, living amidst the accumulations of the past. In our simplicity we cling to human associations. Our thoughts are limited by our surroundings, rubbishy as they are. Architecture from the earliest midden times indicates a striving for the ideal, a searching for something beyond the midden heaps. When we examine the development of civilisation through the ages we find a similarity of customs down to the time when steam power was invented. Changes in building were slow. The steam engine accelerated the pace; a compromise between traditional methods and mechanical production ensued. The old crafts were forced to yield to the feverish demands of a vast population. The change was disturbing. Agriculture gave place to intensive industry. During the 19th century architecture passed through a series of revivals of period styles. Its moods reflected the opinions of the time. This experimental stage had its parallels on the Continent of Europe and in America. From the welter of conflicting opinions, current in the 19th century, has emerged respect for the masterpieces of the past.

At the present time we have two factors to consider; the first is the ordinary view point of the average English architect; the second is the effect of architectural novelty, insular and foreign, upon that view point. The craze at the moment is for originality, or "Modernism." In order to appear original, men begin inventing new names for old things (at Peacehaven there is a shop filled with articles labelled "Moderniques"). We can assume the resisting

forces to be those of efficiency on the one hand and educated taste on the other. If buildings were to be efficient and nothing else, it is conceivable that they would lack pictorial grace. Even an efficient building must have the stamp of character. Therefore, what is termed scholarship or taste should be an essential attribute. By taste is implied order, rhythm, proportion, arrangement and character expression. Those in search of a new style are often careless. There is a mistaken zeal for originality. A novel fashion comes into play, fine building is regarded as obsolete. This carelessness is one of the faults of the age. All sections of modern society mistake novelty for a fundamental truth. Democracy lacking guidance is content with substitutes; beauty and refinement such as our forbears loved have no place in modern ethics.

When mass architecture of the better sort is controlled, it rarely fails to satisfy cultured opinion. We are realising that democracy cannot state its ideals unaided. We have only to examine the riband developments on the main roads to appreciate this fact. I will say with confidence that much good architecture in this country is the outcome of unified control. In the works of public bodies, such as His Majesty's Office of Works, the London County Council, and the Ministry of Health you will acclaim the value of control On the Kennington Estate of His Royal Highness the Prince of Wales you can see architecture called into existence by thought for the inner spirit of the people. I quote these authorities in order to emphasise my point, which is that architecture is the most aristocratic of the Arts. You know it to be the highest expression of culture, a reflection of past and current tendencies; the art of building finely. It should be above the petty annoyances of fashion, and period-style stunt novelty. It should be architectonic. You will say "this is splitting straws—an attempt to define the indefinable. Are we to regard a building as a skeleton structure conforming to some geometrical plan, and is it necessary for an architect to hang the structure with the glad rags of a culture that is obsolete?" Yes and no; this is what I do mean. Architects must be Janus headed. My view is that an architect is in the position of a playwright. His job is to devise the scenario. Let us suppose, to take a simile, that we substitute horizontal lines for vertical ones in an elevation. We shall do this better if we are acquainted with tradition than if we scheme fantastically. Once again we return to the issue of *de gustibus*. I can quote examples of horizontal windows sixty feet long in the warehouses of the London docks built 50 years ago. There is nothing new. We have the cantilevered fronts and the bay windows of Tudor houses that anticipate the cantilevered novelties of Corbusier. We will agree that novelty of statement is possible. For example, you can strip naked, or you can don strange garments, but you cannot change physical principles. Attempts to dehumanise buildings are symptoms of fashion. Such attempts become out of date very quickly. You will remember the fate of the travesty of the Ludovisi throne. . . . . .

If we were a nation of robots we should not need culture of any sort. We should have arrived, and that would be sufficient. Futurism is a form of snobbery.

This is a utilitarian age; it is also an age of survivals. The inevitable compromise between tradition and invention is in process. We have passed from copy-book architecture to an understanding of structure. Because we are underlings present-day architecture is transitory. You are not likely to change building manners by advocating the *robotesque* as a remedy for every artistic shortcoming.

I am sure you will appreciate the difficulties of architects. We are all in sympathy with new ideas but there are few who desire to sacrifice beauty to utility. Later on, when the best buildings of to-day are shown on the screen, you will see how the compromise is working.

English architecture of to-day expresses contemporary life. It can be divided into five categories :—

(*a*). Commercial architecture—offices, banks, warehouses, factories, transport buildings.

(*b*). Housing—town and country houses, cottages, farms, etc., etc.

(*c*). Civil—post offices, town halls, schools, bridges.

(*d*). Religious buildings—cathedrals, churches.

The bulk of the work comes under (*a*). Here we find traditional materials cloaking the skeleton structure which is the real building. We have yet to devise the efficient factory, the attractive city office, the best form of garage, and the right type of bank. The bank, it is true, has gained a certain ostentatious character. Generally, the bank is a classical building bedizened with unnecessary ornament. Scholarship combined with efficient structure is the leaven required.

Housing in town and country comes next. Climatic conditions fortunately must still be observed. During the past four centuries brick has been found the most suitable material. The housing question has evolved a new cottage style for villages and garden cities. The best work of this class has charm; it is free in design, logical, economical, and typically English. The people who live in these new cottages and small houses know little about architecture, but they are content with their homes. Modern housing in towns and cities proceeds on the lines of communal dwellings and flats. The best of the latter have uniformity. The planning is reasonable, the elevations pleasant and sunny. No other country has evolved similar buildings; they satisfy the Englishman's thoughts of home and have a familiarity which is friendly and human. Such buildings represent the view point of English architects.

The civic buildings come next.

I doubt whether you will encounter better post office buildings than those erected by His Majesty's Office of Works. The planning of schools has improved, thanks to the Board of Education. In the design of bridges, England is not

behind any other country. The new Border bridge is among the modern triumphs. The new steel bridge at Newcastle-on-Tyne has all the daring of Telford's masterpieces across the Menai Straits. The new bridge in massed concrete is a thing of beauty. And so on and so forth. But the good things are overshadowed by masses of *mere building*, not fine building

You will be astonished at the excellence of design of many new churches. True, such buildings exhibit Gothic principles, but they are otherwise up-to-date The plan of Liverpool cathedral is original, even if the detail is mediæval. There are churches recalling Byzantine formations, and structures of plain brick, of stone, and concrete, which belong to this age and no other.

Once more I will hold the mirror up to the best of contemporary English architecture and show it to be *architectonic*. In the main it is the outcome of 19th century experiment. But there are some who say that this peculiarly English expression does not go far enough. Such critics would have English architecture more cosmopolitan in character. They would have Englishmen express themselves as Germans, Frenchmen, Americans, Dutchmen, Swedes, and a score of nationalities. It is imagined, somewhat vainly, that other countries hold the formula for architecture Hence the English preference for foreign artists with names ending in "ski" or "stein." How pathetic it is that young Englishmen trained in the schools should be forced to seek employment away from their own country.

We will now examine the foreign influences.

Denmark.—Here the modern architecture is mainly based on tradition. It is orderly, human in scale, unostentatious, reasonable, aristocratic and direct.

Sweden.—Similar to Denmark. More adventurous, more regard for structural integrity, beautiful in detail, economic in expression. Architectonic to a degree.

Germany.—The whole country organised to capture the world's commerce The finest factories, shops, warehouses, and railway stations. Cinemas, theatres, and dance halls of novel character. Domestic architecture generally of the old Nuremberg style, mock half timber, beetle-browed roofs, squint dormers; in this apeing "ye olde English" copy-book style. The reverse shows vast blocks of flats for the workers, strange houses of small scale, built of concrete. The robot population of Germany accepts such things without complaint. Teuton efficiency has produced new factory types. "Modernism" in Germany has made great headway. There is novelty of design in the planning of the larger buildings such as the Tietz stores, and ingenuity in the planning of factories for specific purposes.

The robotesque style has gained ground, but it does not provide a formula for all buildings. There is a tendency to design every new building to the same rulings, with the result that churches resemble factories and cottages are akin to boxes. The new style expresses industrial efficiency, but it is inhuman. Even the Germans refer to it as the marvel of engineering.

France.—The French define the term "modern" as intelligent evolution from tradition. They are right. Such buildings as those designed by the Perret brothers are very good indeed. The aeroplane and liner style of Messieurs Corbusier and Mallet Stephens has gained followers But good sense in architecture and the national regard for artistic culture preserves equilibrium

Holland.—Here we find a definite break with tradition. A new treatment of the national brickwork combined with concrete Novel blocks of working-class houses. Very good factories. A tendency to manufacture design and to dehumanise architecture.

America. - During the 19th century America experimented with the conventional styles of Europe. The culmination came with the classical fever, which added a giant order to the upper works of skyscrapers and adapted the Baths of Caracalla to railway stations. The works of Sullivan and Frank Lloyd Wright represent attempts to give America an indigenous style. They are partly successful, but they do not stand for an universal formula.

The chief contribution of America to the world's architecture is the modern skyscraper. This type of building would not have been possible but for the use of steel for the bones of the structure. The zoning laws have produced *ziggurat* forms. The types have great beauty of silhouette. The vertical line dominates. The cultured view point of America at its best is expressed in the works of the late Charles Goodhue. This is a view point which respects tradition and, at the same time, allows scope for adventure

Now the effect of these cosmopolitan commands upon the mentality of some architects in England is bewildering. There is little chance for steady evolution when all other countries are ruled by the demon of modernism at all costs. The illustrations of foreign buildings which reach English architects by every mail, and at the whim of every photographer, disturb the outlook. Fashion and a new sort of copyism are conjointly producing changes which are far from beneficial. From America has come the rage for skyscraper tops. From Germany has arrived the mania for bestial sculpture. Everywhere we see ill-digested versions of the robotesque. From France we have obtained the Mallet-Corbusier fashion, dictated by economy, frugality, and maturity. The Dutch bulbous style has not caught on, but we have much to learn from the Hollander in the treatment of commercial buildings. The quiet building manners of the Danes and the Swedes, analogous to the English mood of the 18th century, unfortunately are not appreciated.

Small wonder that English architecture should exhibit so many differentiations. When designed by men with knowledge of fine building the result is good. But at the hands of opportunists buildings become reminiscent of present-day continental experiment. At the call of democracy the art of building is at its worst. It has descended to the level of substitute materials such as "bungaroid."

The subject is a difficult one. We must ask this question: Is culture of the human sort to go down before the onslaught of intensive industry? What is there to be gained from the wholesale urbanisation of the countryside, the suppression of good manners and the encouragement of a factory style? Thank God we have not quite reached that stage. We are keen for architecture to be distinctive. We confess to be aware of what is going on in other countries and to be ready to profit by new ideas. But we are tired of hearing that the best English work is old-fashioned, when we know the contrary to be the case My fear is that so-called "modernism" is another name for syncopated stunting, and as such it deserves to be suppressed

CONCLUSION.

In order to view the present disinterestedly I propose to conclude wit

AN IMAGINARY PAPER

(Read in this hall *a century ahead*, in the year 2029).

FRIENDS OF THE ARTS,

The bitter invective which accompanied the development of architecture a century ago is not a little astonishing. In those days public opinion was not alive to the good buildings which were then being erected To-day we view the best buildings of the reign of King George V in a more favourable light. In spite of the apathy of the public and the lesser municipal authorities, some English architects of 1929 had the good sense to continue time-honoured proportions. The mellowed and charming buildings which have come down to us are examples of former skill and good taste. It is owing to these masterpieces that, our present method of designing has reached a high standard. When we think that a century ago architectural education was in its infancy, when we realise that the age was one of transition from period styles to a realisation of fine building, we admire the reticence of the old architects.

It was not until 1950 that the famous Act was passed which prohibited the building of bungalows and small villas on the great trunk roads. The clearance of the ruins of these crude cabins is still in hand. About this time, 1950, the municipal authorities in every large city adopted measures to ensure comprehensive designs for street architecture. Old buildings of historical character were scheduled and preserved by Government; the frightful slums were cleared, and new regulations were framed zoning the trades and factories. Old London, which during the centuries had grown from a walled city to a chaotic sprawl, was placed under the control of a central body. The old parochial, and ward administration now gave place to organisation on the grand scale. London then extended for thirty miles in all directions. Legislation, however, decreed that land speculation beyond this point should cease. The new laws for the revival of agriculture came into being in 1960.

At this time electrical power was developed at the pit head and the hideous grid system of 1932 was replaced by underground *conduits*. The motor roads which were constructed between London, the ports, and the manufacturing centres in 1940 attracted the unwieldy lorries and curious motor cars from the mazes of mediæval roads, thus saving the countryside. These great avenues, since planted with fruit trees, are now the most pleasant walks in the world You can trace their direct course when travelling from any of the airports. More instructive are the old 19th century railroads with their fine viaducts and splendid embankments. The electrically-hauled goods traffic to-day, which is confined to their monumental ways, perpetuates the memory of the canalisation of England two centuries ago. All these internal improvements have had a beneficial effect on the national architecture. We know what it is to enjoy life in town in these days. We shop in comfort at the roof level and we use the pavements as platforms to the moving ways. There is little noise. The city streets have long been closed to wheeled traffic. Life in London to-day is convenient and pleasant. The river is gay with pleasure craft from Oxford to the Nore. Since the factories were removed the smoke nuisance has vanished ; rarely do we get more than a sea mist in town.

The increase in the number of dairy farms thirty miles from Charing Cross is a further sign of the national well-being. England is now largely self-supporting in food production. The curious food markets of central London were decentralised long since, and in course of time it is hoped that the new circular boulevard will create residential centres on the site of the ancient Victorian suburbs.

To-day we have commercial buildings of simple character, which are in marked contrast with the older buildings of the city. People have learnt to inspect goods within the bazaars and do their lounging on the elevated terraces. Who among the public would dream of patronising a store where all the goods were heaped in vulgar display behind a sheet of plate glass. We have reached a stage of taste which controls the external appearance of our streets. The Neo-Georgians of 1929 tried to reface London with Portland stone. We have adopted a veneer of marble for our concrete, besides inventing a surface which forms part of the concrete itself. We still employ brickwork, and shall continue to do so, but we have become more accustomed to colour buildings. The early experiments in thin concrete were found to be unsuited to this climate, as were the long, low windows which came into use about 1940. It was found that the rooms windowed thus were too cold in winter (even when electric heating was cheap). The Neo-Georgians thought themselves modern. In this age when it is criminal for any member of the community to lack good taste it is interesting to know that our ancestors were among the untidy peoples of the then civilised world. After one of their public bank holidays, the lorries used to go round collecting tons of waste paper from the parks. London life was very different then. We have indeed advanced. People are healthier

to-day and live to a ripe old age. England can house and feed her fifty millions with ease. The emigration of whole districts to Canada, Australia, and South Africa in 1970 was one of the wisest moves of that period. Looking back on the year 1929, the close of the first post-great war period, we discern the *beginning of the movement which raised democracy to an appreciation of the spiritual side of existence. Nothing dies, there is only change. We have no desire to probe the mysteries of the inscrutable future, but we know most certainly that in due course the order which has come about will be improved and that generations yet unborn will look back upon this epoch of 2029 as we view the buried past.*

DISCUSSION.

THE CHAIRMAN said he was accustomed to listen at the Royal Society of Arts to first-class lectures, but he thought he had never had his eyes and his ears simultaneously charmed more than that evening. To hear Professor Richardson speak well of the present was in itself refreshing, but to hear him, with the full knowledge of history behind him, speak well of the younger generation and therefore of the future, was even more satisfactory. He (the speaker) had lived in England in the late Victorian period, and, returning here after an absence of nearly a quarter of a century, he had seen a very extraordinary contrast between the past and the present. They must take off their hats to the past and their coats to the future. Professor Richardson had shown how they were taking off their coats to the future, and he (the speaker) thought that every political party in the country should have come to the lecture to be encouraged for the future by looking at what had already been accomplished. There were many persons present who were in a position to add something to what Professor Richardson had said, and he hoped there would be a most free discussion.

PROFESSOR STANLEY ADSHEAD (Professor of Town Planning, University of London) said that when he heard that his old friend Professor Richardson was going to lecture on such a great subject to so distinguished an audience he felt that he should attend, and he had been very anxious to hear those very piquant remarks which he thought would be forthcoming. He congratulated the lecturer that night upon his extraordinary reticence! The lecture had been so tremendously full that it was very difficult on the spur of the moment to say anything about it which would do justice even to some of the less important observations the lecturer had made, but in thinking over the lecture, he felt that perhaps Professor Richardson was at his best when he emphasised how the architecture of 1929 would look in the year 2029. With regard to the general comments that had been made, the lecturer had stated that the success of architecture depended not upon what was put on but upon what was taken off. There was a very great deal of truth in that, but he thought that in the latter part of the 19th century a certain reserved feeling had been manifested by some of our architects, which amounted to the removal of all plumage whatsoever. One of the most prominent features of architecture was that it had a human side; and perhaps the best thing Professor Richardson had said was that architecture was no good unless it was human, and that the tendency of a great deal of modern architecture was to become machine-like or robotesque; very human, but very impersonal. The whole essence of

architecture was to be human, and if it expressed the best kind of humanity then it would be the best kind of architecture.

MR. JOHN HODGSON thought the most important feature of the lecture was that architecture was aristocratic and must be controlled. In all the great ages of architecture it had either been temple architecture or church architecture, and there had been a small group of people controlling a tradition and then gradually developing it. Then when the Victorian Age arrived, when a mass of uncultured people became rich and were able to control architects, all kinds of things occurred. He thought they were getting out of that state now and that a period had been reached when architecture, which had lost its culture, was beginning again to get under proper control. If everybody who ordered a building was able to say exactly what kind of building they wanted, naturally indiscriminate planning and ornament were obtained everywhere The lecture had been amazing. As one travelled about the country, seeing the different buildings depicted on the slides, one felt that it was a wonderful country to live in. He would like to have a list of Professor Richardson's slides so that he could go round the country and see actually how beautiful it was The developments in England were quite up to those in Sweden, Germany or Denmark, and, what was more, the structures were built according to English tradition. There had been the criticism by Professor Richardson in respect of "funnies," which he thought he would like to see done away with. Of course, all decoration in architecture was put there for the sake of association. There was the simplest form of decoration, first of all the basket mark in pottery before the invention of the wheel for moulding When primitive man made pottery one got the impression of basket work with it. When the wheel was invented for making pottery, it was still felt that pottery should have the basket-work appearance on the outside, and so man decorated his pottery with the old basket-work impression he had become accustomed to see. The same thing was seen in the great concrete buildings around London; there were the lines in the stones, because we had got used to looking at that sort of thing. There were other instances, the early English carvings in the cathedrals, and the festive ornaments on the stone, which represented what were originally decorations for special days, but became a permanent thing in every building. Then when a new industrial age arrived, the people did not understand the tradition that had grown up, and they naturally had to clear the way and build a new tradition of their own. He thought that stage had now arrived. Much of the tradition of the past was not understood, and the classical architecture of the Greeks and of those who carried on the Greek tradition, was not thought so much of, but they were buildings of simplicity and grace of form. He was thoroughly in agreement with Professor Richardson that ornament should not be put on buildings which was not part of the design. He was extraordinarily pleased with the lecture which Professor Richardson had given.

MR. GODFREY GILES, P.I B.D., said that after such an admirable lecture he could not help feeling that some of the oldest of the audience must have learned a great deal. Professor Richardson had shown pictures of buildings which were absolutely plain. He (the speaker) was not an architect, and possibly, therefore, he was one of those who could not quite appreciate Professor Richardson to the uttermost. He noticed in one of the pictures that one of the buildings had no cornices. There might be a certain dignity in such utter simplicity, but he thought that some beauty also was lost in having a building which was like a match-box in design. In London two very distinct types of buildings had recently been erected. There was one

block of buildings in Park Lane, with funny little things on the top, otherwise the block was quite square. He noticed only that day that some columns were being erected, so that possibly it might be all right when it was finished. Then there was Regent Street as it was to-day. Probably Professor Richardson would contend that Regent Street was too ornate, but, personally, he thought that Regent Street was very fine, and that if the block of buildings in Park Lane to which he had referred had a little more of the Regent Street touch, and was a little more classical, it would be an improvement. He was very grateful to Professor Richardson for his excellent lecture.

THE CHAIRMAN said he had never with greater pleasure heard anybody speak on the subject of architecture. There had been no gratuitous praise of foreign buildings, which was particularly pleasing. Dr. Johnson defined prejudice as "belief which has survived its original justification," and a great many prejudices had to be faced in this country in regard to architecture as in other matters. A good deal had been heard as to objections to ornamentation, "funnies," etc., but he could not help feeling that ornamentation of buildings was largely a matter of taste, as, for example, in the question of moustaches and beards This depended on the country and the period in which one lived. He was recently studying architecture of the period 4,000 B.C., and found it did not err on the side of simplicity. There were great masses of brick, and in high relief thrown out from the brick were, not gilded but golden bulls, fifty in a row. He was not without hope that that sort of thing might reappear. Professor Richardson had not referred to the difference in national architecture caused by the amount of shade that might reasonably be expected during the year. He had noticed, for example, that in Central America, under the Equator, buildings tended to take quite a different shape and form owing to the fact that shade was practically absent at noon. As for the people who were supposed to lay down precisely what kind of buildings they required, he had had some experience of architects, and he could assure the meeting that the public did not get away with it quite so easily. One might tell an architect what sort of building was required, but that was only the beginning of the battle, and in the long run it was the architect who built the house. It was well that that should be so, because it was worth a good deal to live in a good house. Mr. Richardson mentioned that in 2029 they would be beginning to clear away the "rubbish" (the bungalows) built along the roads, but he was doubtful whether those buildings would last so long, as the work was so inferior in many cases. In his opinion, they would not last until 1969, and no compensation need be paid for them being cleared away. He had lived most of his life in tropical countries, and he could not help thinking that they were making too much of a fetish of sunlight just now. He believed that our 16th century ancestors, before the window tax ever came in, had very good reasons for wishing to keep the sunlight out. Sunlight in a house was a source of considerable irritation if shining on one direct, and people who were healthy and who were living an out-door life did not sit in the sun for choice. He thought that the modern fad for sunlight in the house would probably go, like other fads. What was required was light. He would conclude by reminding the audience that, although the present lecture was a very exceptional one, week by week excellent lectures could be heard at the Royal Society of Arts on a variety of topics, dealt with by persons as well qualified to deal with their respective subjects as Professor Richardson was qualified to deal with his subject. He suggested that those present who were not members of the Royal Society of Arts should become enrolled as such. Membership of the Royal Society of Arts was not a claim to expert knowledge or scientific proficiency;

it was a distinguished fellowship designed to encourage the arts, science and commerce of this country. It was a fellowship of desire rather than of accomplishment, and he knew of no society in London which could inform its members so well or so regularly upon every topic of current importance as the Royal Society of Arts. It was not everyone that could attend a weekly lecture in London, but those who were living in London would find themselves very amply rewarded. He asked them all to extend to Professor Richardson their hearty thanks for an exceedingly valuable lecture which must have taken him a very great deal of time and trouble to prepare

The resolution of thanks was carried unanimously

PROFESSOR RICHARDSON, in reply, said his object in showing the slides was to give the sum total of the best current work of the post-war period, which personally he liked. There might be more advanced things, but that work was a very fair sample of what was going on, and if the general level could only be raised to that extent there would be no cause for complaint He thanked them all for listening to him so attentively.

The meeting then terminated.

OBITUARY.

ROBERT SKELTON.—Mr. Robert Skelton, who died on April 27th, at his home at Harrow, spent nearly the whole of his working life as engineer to the Municipality of Colombo, Ceylon. Born in London in 1863, he received his technical education at King's College, London, and on passing out "with high distinction," he was articled in 1884 to his teacher, Professor Henry Robinson, M.Inst.C.E., who, on the completion of his articles, in 1886, retained him as his assistant During the following two years Skelton was employed in carrying out surveys and drawings for a number of waterworks and sewerage disposal schemes, until in 1888 he was appointed an assistant engineer in the Ceylon Public Works Department. Soon after his arrival in Ceylon he became Municipal Engineer at Colombo, and during his tenure of this office extending over nearly thirty years he was responsible for a number of important improvements, including the formation of a City Sanitation Department and a Waterworks Department. He was also keenly interested in town-planning and road construction, and one of the great thoroughfares which he planned was named by the City Council "Skelton Road," in recognition of his services. After his retirement in 1915 he took a considerable interest in Egyptology Mr. Skelton was elected an associate member of the Institution of Civil Engineers in 1888, and became a member of the Institution of Municipal and County Engineers in 1895. He had been a Fellow of the Royal Society of Arts since 1903.

INTERNATIONAL EXHIBITION OF COMMERCIAL ARCHITECTURE.

INTERNATIONAL EXHIBITION OF MODERN COMMERCIAL ARCHITECTURE, R.I.B.A. GALLERIES 9, CONDUIT STREET, LONDON.—"Ferro-concrete," says Mr. Goodhart-Rendel at the end of his preface to the catalogue of this exhibition, "is no longer new or exciting, it is part of our daily lives. . " Indeed, a large number of

people may further have discovered that a very useful kind of concrete, not actually ferro-concrete, but a medium of tremendous strength, was extensively used by the Romans. A superficial knowledge of the Wonders of the Ancient World soon cures the tendency to overrate the wrong, *i.e.*, the purely technical, elements of modern building. We have more money than the Ancients, but they had more time and more labour at their disposal, and the hugest skyscraper has not more impressive proportions than an Assyrian ziggurat or the pyramids of Gizeh.

The skyscrapers do not come very well out of the present ordeal of comparison with European architecture. In general, they have in common with certain Gothic churches a naturalistic quality, a suggestion about them that they grew up out of human control. Some people like this quality: they will like the skyscrapers. And in fact the application of classical features to these disproportionately tall houses is apt to be a complete failure. An illustration of this is afforded by Eric Mendelsohn's photograph (in his book, "America") of the portico of the Federal Reserve Bank, Chicago. As the author dryly comments: "Greece as beast-of-burden (*lastesel*) of steel construction." Even so, the Ionic Order is like a blessed glimpse of an oasis in this desert of walls and windows.

The less lofty American buildings shown are not particularly attractive, No. 38, a Chicago warehouse, could hardly be more depressing, combining, as it does, the gloomy characteristics of a medieval dungeon—erected for the utilitarian purposes of war—and a nineteenth century factory or lunatic asylum. But before reaching 38 we have already observed that modern warehouses can be simple and fine: the point is proved by 30, warehouse at Basle, Switzerland. And our spirits have also been raised by 36, Eric Mendelsohn's hat factory at Luckenwalde, Germany. The Einstein Tower may be the best known, but it is no doubt far from being the best work of this very talented architect.

The hat factory is wholly original, and it is as plainly a deliberate human creation as the skyscrapers are the outcome, largely, of circumstantial pressure. No. 44, factory, Paris (interior), is a gaunt, apparently concrete, building, not merely saved from banality, but made really interesting by a stroke, one might say, of genius. The great circular arches give æsthetic unity to the room and infuse the whole space with life and rhythm.

Neither Dr. Van Heukelow's Railway Offices, Utrecht, Holland, 51, nor the office building, Lubeck, Germany, 59, are any the less forcefully modern for their embodiment of traditional elements. In the former we see Gothic repetitions without Gothic spikes and frills; in the latter, the outlines of a typical German Rathaus. In both cases brick is used with admirable effect. At last, with 97, Courtauld's new premises, London, we come to an English building that we can admire. The treatment of the square columns which are the chief feature, is masterly; they might well have become unmanageable, but with a roof of sufficient weight and a fine doorway they make a strong combination.

In architecture, as in other respects, the French second class is better than the second class of other peoples. The shop front in the Faubourg St. Honoré, No. 109, is not first rate, but it is very good. Altogether, the French deserve great credit for leading the revolt against those expanses of glass in the ground floors of shopping streets, which have had such a devasting effect on urban architecture. Bourne and Hollingsworth's in Oxford Street is a classical example of the abuse; Paris Trades in Berkeley Street an example of the reaction. At least, if there is going to be a good deal of glass, let the superstructure be light and airy, as the eminent French architect, Rob Mallet-Stevens, can make it.

Holzmeister's Festival Theatre at Salzburg, Austria, 148, is beautifully unostentatious and reserved, while Poelzig's Capitol Theatre in Berlin is beautifully

luscious and dazzling: somehow like a brass band or a shower of stars from a gigantic rocket. (157, interior.) Here the fireworks are so well organised that they thrill and do not offend: there is a difference between Santa Maria della Salute and the mouldings on the ceiling of a late Victorian drawing-room.

Professor Tengbom's Concert House, Stockholm (172-3-4) is a very successful adaptation of the classical. The portico is magnificent. The Corinthian capitals are not too ornate, and the columns are given a modern feeling by being cut into facets and having the joints of the masonry well marked. At the opposite pole of derivative work are the flats in the Paseo de Gracia, Barcelona, No. 235, which, however, it is difficult to judge from a single photograph. No. 238 shows some flats on the Larkhall Estate at Clapham, built by two architects with foreign names, but in a style that is well suited to the environs of London—very different from the grottoesque, or truly grotesque, of the Paseo de Gracia.

Is there a good deal to be said for the Stuttgart Railway Station of Paul Bonatz? The masses are excellent; but is there not perhaps something uncivil about the texture of the surfaces? In itself the station is imposing and agreeable; the question is, does it harmonise with its surroundings, or, let us say, with the best probable surroundings that it is likely to get in a central European town?

Included in the exhibition is a big model of the new Underground building at the end of Tothill Street. The plan is a worthy, if not actually a very pleasing one, and the building will deserve the name of architecture. It is perhaps too big to be altogether humanly congenial, but is not too lanky nor too over-developed in any of its members. On our round globe and with our round heads we seem to have some deep-seated prejudice in favour of domes rather than of flat-topped towers: there is a touch of the primitive or the barbaric about these, a suggestion of Polyphemus with his solitary eye.

A most interesting and most useful exhibition. Everyone should go.

NOTES ON BOOKS.

THE THEORY OF FILM LUBRICATION. By R. O. Boswall, B.Sc. (Eng.) Lond., M.Sc. (Tech.) Manchester, Lecturer in Mechanical Engineering in the College of Technology and in the University, Manchester. London: Longmans, Green & Co., Ltd. *12s. 6d.*

The term "film lubrication" of bearing surfaces implies the maintenance of a continuous film of lubricant between the surfaces in question, which are thus definitely preserved from mutual contact. From the point of view of reduction of both friction and wear it is highly desirable that this condition should be fulfilled in all machinery, and a gradually increasing sense of its importance is to be noted in modern bearing design. The foundations of the subject were laid by certain observations made in 1883 by Beauchamp Towers, leading to a general theoretical treatment by Osborne Reynolds in 1886.

The essential observation was to the effect that, when proper measures were taken to supply unlimited oil in the right places, the lubricant at the bearing surface of an ordinary journal was sustaining a heavy hydrostatic pressure. This pressure, which was measured by the simple device of boring a hole right through the bearing to the journal at any desired spot and inserting a pressure-gauge, was found to vary from spot to spot, falling to atmospheric value all round the edges; but when the various local values were integrated over the whole area, the sum

was found to be almost exactly equal to the total load on the bearing. It was therefore evident that the entire pressure was in fact being borne by the oil-film, no direct metallic contact occurring between bearing and journal; and it was further observed that, when this desirable state of affairs was set up, the frictional resistance fell to a small fraction of its (variable) value under the normal conditions of limited oil-supply by syphon or pad.

The subsequent mathematical investigation by Reynolds, in which it was assumed that the ordinary conditions of viscous flow were applicable to the oil-film in the bearing, has been greatly extended in subsequent years, but until now no text book has appeared to collect and criticize the results. Mr. Boswall, by assembling his own researches and those of others in this field, has performed a notable service to all those interested in the subject of lubrication.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, MAY 27..Architects, Royal Institute of British, 9, Conduit Street, W. Mr. H Percy Adams, "English Hospital Planning."
Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p m Mr L. J. Robbins, "A Journey in Central Siam"
Surveyors' Institution at 12 Great George Street Westminster, S.W. 5 p.m. Annual General Meeting
University of London, at King's College, Strand, W.C 5.30 p.m. Rev. G. Galloway, "Religion and the Transcendent." (Lecture I)
At the London School of Economics, Houghton Street, W.C. 5.30 p.m. "Some Modern Philosophies of History." (Lecture IV). Pr Dr. A F Pollard, "History and Philosophers."
Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m Sir W M Flinders Petrie, "Materialization of Old Testament History."

TUESDAY, MAY 28..Anthropological Institute, 52, Upper Bedford Place, W.C. 8.30 p m. Mrs. M. Hasluck, "Turkish Games."
Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Mr. A. Loveday, "The Measurement of Tariff Levels."
University of London, at Birkbeck College, Bream's Buildings, E.C. 5.30 p.m. Prof Sten de Geer, "Sweden and the North of Europe" (Lecture II).
At King's College, Strand, W.C. 5.30 p.m. Prof Anathon Aall, "The Hellenistic Element in Christianity." (Lecture III).
5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture V).
At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. Luigi Einaudi, "Taxation." (Lecture I).
At University College, Gower Street, W.C. 5.30 p.m Prof. A. Brachet, "Experimental Embryology." (Lecture I).
5.30 p.m. Mr. Robin Flower, "Life, History and Folklore of a Kerry Island" (Lecture II).
Zoological Society, Regents Park, N.W. Scientific Business Meeting, 5.30 p.m.

WEDNESDAY, MAY 29..Eugenics Society, at Burlington House, W. 8.30 p.m. Mr. E. B. Ford, "Recent Work on the Physiology of Genetics and its Bearing on Human Problems."
Geological Society, Burlington House, W. 5.30 p.m.
University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. G. Galloway, "Religion and the Transcendent." (Lecture II).
5.30 p.m Colonel C N F Broad, "Modern Ways with Ancient Tasks: a Study of Mechanisation."
At the London School of Economics, Houghton Street, W.C. 5 p m Prof Luigi Einaudi, "Taxation" (Lecture II).
5 p.m. Dr Hubert Hall, "The Nature, Value and Uses of English Judicial Records as Sources of Economic and Social Information" (Lecture V)
At University College, Gower Street, W.C. 5 30 p.m Prof A Brachet, "Experimental Embryology" (Lecture II)
5.30 p m Prof E. D Wiersma, "The Psychology of Dementia" (Lecture I)

THURSDAY, MAY 30. Birth Control and Racial Progress, Society for, at Essex Hall, Essex Street, W C 8 p m Dr Mather Thomson, "Sterilization of the Unfit."
Chadwick Public Lecture, at the Chelsea Physic Garden, Swan Walk, S W. 5 p m Mr. H V. Taylor, "Supplies from the Vegetable Kingdom and the Public Health"
Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S W 5.30 p m. Prof. W. H Perkin, F.R.S., "The Early History of the Synthesis of Closed Carbon Chains" (Pedler Lecture)
University of London, at Birkbeck College, Bream's Buildings, E.C. 5.30 p.m. Prof. Sten de Geer, "Sweden and the North of Europe" (Lecture III)
At King's College, Strand, W.C 5.30 p.m. Ifor L. Evans, "Agrarian Reform in the Danubian Countries" (Lecture V).
5 30 p.m Prof. P Karrer, "Organic Chemistry" (Lecture I).
At the London School of Economics, Houghton Street, W.C. 5 p m Prof. A. Aall, "The Psychology of the Individual and of the Mass" (Lecture I).
At St. Thomas's Hospital, Albert Embankment, S.E 5 p m. Prof. S. J. Cowell, "Dietetics" (Lecture V)
At University College, Gower Street, W.C. 5.30 p.m Prof. E. D. Wiersma, "The Psychology of Dementia" (Lecture II)

FRIDAY, MAY 31..University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. G. Galloway, "Religion and the Transcendent." (Lecture III).
5.30 p m Dr. Otakar Odlozilik, "Good King Wenceslas. an Historical Sketch."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. A. Aall, "The Psychology of the Individual and of the Mass." (Lecture II).
At University College, Gower Street, W.C. 5.30 p m Prof. A. Brachet, "Experimental Embryology." (Lecture III).
5.30 p.m. A Lecture on the Recent Discoveries of the British School of Archaeology in Egypt at Beth-peleth Palestine, by Prof. Sir Flinders Petrie.

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, MAY 31st, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

COUNCIL.

A meeting of the Council was held on Monday, May 13th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward Gait, K.C.S.I., C.I.E.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Mr. Alan A. Campbell Swinton, F.R.S.; Mr. Carmichael Thomas; Professor John Millar Thomson, LL.D., F.R.S.; Sir Frank Warner, K.B.E., and Sir Alfred Yarrow, Bt., F.R.S., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant-Secretary).

The following candidates were duly elected Fellows of the Society:—

Aisbett, John Carnegie, Melbourne, Australia.
Batt, Edwin G., London.
Brown, Harold George, A.M.I.E.E., Bakewell, Derbyshire.
Butler, Alan Samuel, London.
Byard, Miss Betty A. M., L.L.A., London.
Child, Nicholas Gilbert Louis, B.A., Aston Tirrold, Berks
Chumley, Alick, Hove, Sussex.
Davies, James F., Sutton Coldfield.
de Kazarine, Serge, London.
Dixon, Charles William, Grimsby.
Duff, Alderman James A., J.P., Belfast.

Duff, Reginald James, J.P., Bombay, India.
Elton, Charles John, Merstham, Surrey.
Erulkar, David S., London.
Fothergill, John Rowland, Thame, Oxon.
Gardiner, Sir Frederick C., K.B.E., LL.D., D.L., J.P., Glasgow.
Hall, Ernest Byfield, Market Drayton, Salop.
Heide, Henry Conrad, London.
Hirachand, Walchand, Bombay, India.
Hollick, Thomas Drake, Sheering, Essex.
Hooper, Cecil H., Wye, Kent.
Hooper, Professor William James, Battle Creek, Michigan, U.S.A.
Hudson, Arthur William, London.
Hughes, Walter Martin, J.P., Bilston, Staffs.
Iliffe, William Coker, London.
Insull, Martin J., Chicago, Ill., U.S.A.
Jamieson, William, Powell River, British Columbia.
Kapur, Diwan Ram Chand, Benares City, India.
Neate, Rayner Maurice, M.A., LL.M., London.
Nicol, E. W. L., Assoc.I.C.E., A.M.I.E.E., London.
Nicoll, Miss Bertha, London.
Parker, George Vernon, Reading, Berks.
Perera, Wilmot A., Horana, Ceylon.
Prosser, William Richard, Bangalore, India.
Rajamannar, T., Madras, India.
Reid, David, Coatbridge.
Rolls, Colin, London.
Somerville, William Lyon, A.R.C.A., Toronto, Canada.
Stewart, Andrew, Angus, Bengal, India.
Telford, John Charles, O.B.E., M.Inst.C.E., Pedmore, Worcs
Umney, Ernest Albert, London.

The question of the award of the Society's Albert Medal for 1929 was further considered, and names were selected for submission to H.R.H. the President

The preparation of the balloting list for the new Council was completed.

Sir Philip Magnus was re-elected Chairman of the Examinations Committee

It was reported that the number of entries for the May examinations was 53,576, an increase of 1,820 as compared with the total for 1928.

It was reported that the conditions of sale of West Wycombe had been duly signed on behalf of the Council by Sir George Sutton, Chairman of the Council, and Mr. P. Morley Horder, Chairman of the Executive Committee of the Fund for the Preservation of Ancient Cottages, and that one-quarter of the purchase price had been paid.

The thanks of the Council were accorded to Mr. James H. Hyde for a further contribution of £500 to the Fund for the Preservation of Ancient Cottages. Mr. Hyde has now contributed £2,025 to the Fund.

A committee was appointed for the purpose of adjudicating the award of the Society's silver medals for papers read during the session 1928-29.

The arrangements for the next session, 1929-30, were considered.

A quantity of financial and formal business was transacted.

PROCEEDINGS OF THE SOCIETY.

DOMINIONS AND COLONIES SECTION.

TUESDAY, 26TH MARCH, 1929.

PROFESSOR J. G. LAWN, C.B.E., A.R.S.M. (Vice-President of the Institution of Mining and Metallurgy), in the Chair.

THE CHAIRMAN said it gave him the greatest pleasure to preside, firstly because the lecture was by his old friend Mr. Warington Smyth, and secondly because it was under the auspices of the Royal Society of Arts. Mr. Warington Smyth had a heritage of mining knowledge his father, as those of the older generation of mining engineers would remember, had been the Professor of Mining at the Royal School of Mines from its inception for a very long period. Mr Warington Smyth himself had been associated with mining during his professional life Although not a professional mining engineer he had been Secretary of Mines both in Siam and for some 25 years in South Africa and therefore he knew a great deal about the subject. The association with the Royal Society of Arts was rather more remote. He (the Chairman) had not had the pleasure of studying under Sir Warington Smyth, because Sir Warington had died while he was a student, but Sir Warington's successor had been Sir Clement le Neve Foster, whose father, Mr. Peter le Neve Foster, had worked for many years as Secretary of the Royal Society of Arts, doing so much to build it up and to put it into that position for useful work which it occupied today Therefore, in regard to both those connections, he was very glad to be present.

The following lecture was then delivered:

THE BASE METAL AND MINERAL RESOURCES OF SOUTH AFRICA.

By H. WARINGTON SMYTH, C.M.G., M.A., F.G.S.,

late Secretary for Mines and Industries for the Union of South Africa.

The following notes have been compiled with a view to bringing into concise form a summary for the special benefit of those who may be visiting South Africa with the British Association during the present year.

The mineral laws of the Union make a clear distinction between precious metals (which include gold, silver and platinum), diamonds, which are legislated for separately, and other so called " base " metals and minerals.

In regard to precious metals, the legislature in all the Provinces (with certain exceptions in Natal), has reserved special rights to the Crown which strictly limit the rights of the owner of the land, who otherwise holds the mineral rights, and gives the State a very large interest in the production. With these minerals and with diamonds I am not dealing in this paper.

In regard to diamonds, again, a whole series of enactments has been passed, both by the separate Provinces and the Union, reserving rights to the Crown and to the public against the owner of the land and of the mineral rights and also providing special regulations with regard to the diamond trade.

As regards, however, the remaining groups of metals and minerals, the rights of the owner who holds the mineral rights have been left intact, and, except where there may be a special reservation, the owner is entitled to deal with his minerals as he thinks fit. He may alienate them or he may work them, subject of course, to the usual Government Regulations with regard to safety of underground working, etc.

A great deal has been written about the base metals and minerals of the Union of South Africa. The number of sources of information dealing with this subject makes it somewhat difficult for the ordinary person to find at once all the information he wants with regard to the " every day " minerals of the Union, and the object of this paper is to assist the enquirer in finding the sources from which information can be obtained and to summarize existing data. The whole subject is dealt with at greater length in the Union Government's Year Books, Geological Survey Reports, the Mines Department's Reports, and the pages of the Journal of Industries, in admirable papers written by my old colleagues, Rogers, Kynaston, Du Toit, Mellor, Hall, Wagner, of the Geological Survey, and, on the technical inspection of mines side, Swinburne, Trevor, Fergusson, Steart, Vaughan, Hutton, Jourdan, Bottomley, and I must not omit to mention my old friend Kotze, the late Government Mining Engineer. No country, I venture to say, has ever had a finer body of scientific and technical men in its employ. I should refer the inquirer to the very excellent Bibliography given in pp. 203-212 of the Chapter by Major Tudor Trevor, A.R.S.M., late Inspector of Mines, South Africa, on the Mineral Wealth of the Union in a publication of the Department of Mines and Industries entitled "Industrial Development in South Africa," published by the Government Printing Works. The Chapter in question provides the best summary to be had on the minerals of the country.

TABLE I.* COAL PRODUCTION—UNION OF SOUTH AFRICA.

Year.	Transvaal.	Cape.	Orange Free State	Natal.	Union of South Africa.	
	Tons Sold.	Tons Sold.	Tons Sold.	Tons Sold.	Tons Sold.	Value at Pit's Mouth.
1915	5,202,805	46,850	727,553	2,304,116	8,281,324	2,142,479
1916	6,136,913	41,752	762,576	3,066,261	10,007,502	2,739,665
1917	6,641,229	8,300	843,095	2,890,296	10,382,920	3,275,608
1918	6,438,961	4,654	826,577	2,607,133	9,877,325	3,224,597
1919	6,622,313	4,759	838,059	2,801,004	10,266,135	3,416,244
1920	. 7,180,124	5,700	966,034	3,321,606	11,473,464	4,519,665
1921	. 6,947,362	5,778	917,776	3,525,989	11,396,905	5,072,401
1922	. 5,380,294	6,813	729,113	3,618,093	9,734,313	3,395,170
1923	. 6,742,289	6,359	865,496	4,302,892	11,917,036	3,713,706
1924	. 6,790,689	5,329	982,596	4,713,291	12,491,905	3,824,746
1925	. 7,397,395	5,608	974,324	4,622,339	12,999,666	3,862,118
1926	. 7,593,468	5,201	976,245	5,159,549	13,734,463	4,046,620
1927	. 7,405,619	4,430	1,039,905	4,852,826	13,302,730	3,825,664
1928	. 7,669,374	5,059	1,088,109	4,641,365	13,403,907	3,697,611

* The values at the pit's mouth were as follows .—Transvaal, from 4s. 4d. to 6s. 7.32d. ; Cape, 11s. 4.22d. to 15s. 9.12d. ; Natal, 6s. 9.50d. to 10s. 7.41d. ; the period of greatest cost being from 1919 to 1921.

COAL. (Table I.)

Next to the gold mining and diamond industries of South Africa, the most important mineral production has been, and is likely to be, that of coal. It is certain that the gold mining industry of the Witwatersrand could never have progressed as it has done, without the cheap and efficient coal which has been available from almost the earliest years, to assist the mechanical side of its production. To-day, a large proportion of the power requirements of the Rand is supplied by electric power companies, but the very existence of these companies depends on the cheap coal which is available close at hand.

The coal measures lie in what is called the Middle Ecca sand stones of the Karroo System. The area is so large that it is not possible to make an accurate estimate of the actual resources of the country in coal. A good deal of work on this point has been done by the Geological Survey, and especially by my old friend, Mr W. J. Wybergh, who was my first chief in South Africa under Lord Milner, and who has given much time, ability and industry to the work of tracing the line of coal deposits and estimating the coal resources of the Union under the ægis of the Geological Survey

The first real discovery of coal was that recorded by Dunn and North in 1878, in the Stormberg beds of the Cape Province (then Cape Colony). A second-rate coal has been produced from this area for some years, but at a high cost; and, unfortunately, no valuable coal of decent quality or extent has ever been discovered in the Cape Province, nor, I fear, is likely to be found

COAL IN NATAL

Natal, speaking generally, is better known for its coal than any other Province owing to the fact that the coalfield is situated within a moderate haulage distance of the Port of Natal, and that a considerable export and bunker trade has grown up at that Port, which has made Durban one of the important harbours of call in the southern hemisphere.

Natal collieries are situated in the areas of Klip River, Dundee, Newcastle, Utrecht, Paulpietersburg and Vryheid, over an area of some 2,000 square miles. There are 29 producing collieries all situated within an average distance of about 240 miles of the Port of Durban.

Coal has also been found in Zululand, but it is apparently of a rather dirty and anthracitic character. Further discoveries, however, may take place in this district.

From time to time, questions have been raised as regards the quality of certain Natal coals exported or bunkered, and in 1923 a Commission was appointed by the Government of Mauritius to make enquiries regarding certain supplies of coal to the Mauritius Railway alleged to be from Natal, upon the character of which unfavourable comments had been made.

Generally speaking, Natal coals are of good quality and the following are analyses of typical Natal coals :—

ANALYSES OF NATAL COALS.*

Name of Colliery.	Moisture	Volatile Matter.	Fixed Carbon.	Ash.	Calorific Value as per Mahler Bomb Process.	Sulphur
Dundee Coal Company (Burnside)	0.56	23.74	68.40	7.30	15.05	1.48
Natal Navigation	0.90	21.78	69.91	7.41	14 to 15.15	1.30
Durban Navigation ...	1.40	30.40	58.50	9.70	13.80	0.94
Northern Navigation ...	2.00	25.30	64.50	8.20	14 to 14.50	0.83
Holbane	1.50	19.30	68.30	10.90	13.84	0.96
Enyati	1.70	22.20	67.80	8.30	14.40	0.84
Tendega	1.20	21.70	69.10	8.00	14.23	0.75
Wallsend	1.25	20.75	66.60	11.40	13.84	

* Report of Coal Commission, 1921.

My Department took steps to clear the character of the Natal coal by referring the matter to the Natal Coal Owners' Society, and to the Technical Officers of the Department. The result was that it was found that in 1920/21, the time when the coal was exported, there was an abnormal demand combined with a truck shortage on the railways, and the dealer took the coal without stipulation as to quality, of a class not usually supplied for shipment, but which is usually used for household purposes.

It is, one would think, fairly apparent that, wherever you may try the experiment, to purchase household coal, and then sell it for raising steam on sea-going ships, is a sure way of causing disappointment and even some unnecessary bad language in the Merchant Marine. It must be a trifle unfair and very misleading to attempt to judge the standard of production of any coal-field by such a method.

As the analysis shows, Natal coal, while admittedly not equal to the best Welsh, is comparable with English North country coals having a calorific value from 13.80 to 15.15. It is used regularly by such steamship lines as the White Star, Blue Funnel, P. and O., and Union Castle, and the general opinion at sea is that it is a good steaming coal.

The stress of competition has long compelled Natal Collieries to exercise the greatest care in sorting and screening, and the Union Government has lately passed an Act under which no coal can be exported or sold unless accompanied by a certificate guaranteeing the grade of the coal, which is fixed by a Grading Committee on which a representative of the Government Department of Mines sits, or is Chairman.

Figures of production are given in Table I.

Natal Collieries, as a rule, have a considerable amount of gas, and in the history of the coalfield some very serious explosions have occurred from time to time. The fact that the seams are known to be fiery and that fire is a constant source of anxiety has induced a careful system of working both by managements and men, and experienced colliers, generally from England, are employed in every mine as supervisors of the native and Indian labour force.

The coalfield is intersected by a number of basaltic dykes which have imprisoned the gas in a series of large gastight compartments, so to speak, and the overlaying of the seams, in some cases, by sheets of a similar character, has prevented the escape upwards of the gas, and has rendered the working of these seams much more difficult and troublesome than those of the Transvaal where similar conditions do not exist.

Stone dusting is carried on at some of the more important collieries, and the dust is constantly sampled to assist in the detection of danger. The collieries which may be specially mentioned are Durban Navigation, Natal Cambrian, Natal Navigation, South African Colliery and Burnside The accident at the latter mine in 1922, when 20 persons lost their lives, was believed to have been caused by a native opening his safety lamp. Electric lamps are now being installed at many collieries, and they give a far better light, of course, than the old oil burning safety lamp, and enable better examination of the working places to be made. The old-fashioned lamp, however, still has to be carried for gas testing purposes, and it remains probably the best practical indicator of danger in the hands of the experienced.

Electric coal cutters are coming more and more into favour and are successful in increasing the output where there is a good roof. The pillar and stall system of working is giving place to the long wall system in many collieries.

The length of the travelling ways is extending year by year, and causing a distinct problem to managements. A three mile trip underground with a low roof cannot increase efficiency of shifts underground, and mechanical haulage must be more and more resorted to

The class of labour employed is, to a large extent, from the Indian coolie population, with a certain number of Kaffir boys; the latter are generally of a stronger physique than the former, but the Indians are more intelligent and can earn better pay. The number of whites employed in these mines is considerably less in proportion to coloured men than is the case in the gold and metalliferous mines, and there has been a tendency to criticise the value of the industry to South Africa on this ground, and to complain that it is merely wasting one of South Africa's most valuable assets by exporting it Such notions take, of course, a very short view of the value of an industry to a country.

That there has been waste both in the mining and the method of utilising coal in the past is undoubtedly true. The two seams which exist close together in a great part of the Natal coalfield near Hattingspruit and Dannhauser, have doubt been worked wastefully, but there have been great difficulties to overcome in operating with the two thicknesses of coal so close together, and in waste in the utilisation of coal the whole world is the culprit.

The two seams are known as the Top and Bottom in the Hattingspruit district, and the Alfred and Gus in the Vryheid area. Both seams and the parting vary thickness, the latter being at times as much as 40 feet.

A typical section through these seams gives :—top seam 3ft. 6ins.; sandstone nd shale parting 2 to 4 ft.; bottom seam, 4ft. 6in.

While many of the collieries are so placed that they can be worked by adit in the hillside, these in the Hattingspruit district are worked by shafts, but do not exceed 700 feet in depth anywhere.

In working these seams, failure to leave large pillars to separate the mine into panels, and the leaving of the upper seam have resulted in heavy falls and gob fires, which have caused the direct loss of large areas of coal. Managements have realised the danger and the loss involved, and at some mines the difficulties are being met effectively, as at the Durban Navigation. It would take too long to recount the methods adopted, which are chiefly interesting to coal mining men.

Natal is already doing something to clear itself of the reflection that it is only exporting ruthlessly one of the country's assets. In 1922, the Dundee Coal Company completed the erection of a very up-to-date plant for dealing with bye-products of the coal at Waschbank. The works can produce 700 tons of coke weekly, 25 tons of tar, 8 tons of sulphate of ammonia, and small quantities of creosote and naphthalene. There is now a steady output from this and other similar plants in the Union.

COAL IN THE TRANSVAAL.

In the Transvaal, coal was first systematically opened up near Boksburg in 1887, and it was this find in close proximity to the Rand which first held out the hope of being able to work the Rand beds on a large scale. Thus, on the East Rand there has been the remarkable spectacle of an area of ground proclaimed under the Gold Law for gold, producing coal from the same portion of land, the gold being worked under the Gold Law and subject to the Government's administrative control under that Act, while the coal is the property of the owner of the farm and worked by him under his ordinary base-mineral rights.

Coal in the Transvaal is found in four distinct geographical districts and is probably very extensive.

(*a*) The present production comes from the High Veldt in the neighbourhood of Witbank, roughly in the area between the Eastern escarpment of the High Veldt and the Natal and Delagoa Bay main lines of railway, an area of some 500 square miles.

(*b*) The Bushveld area north of Pretoria. The coal measures here are of considerable thickness but the coal is probably not of very good quality.

(*c*) The Lemombo area along the Eastern border of the Transvaal in the low country. This coal appears to be a good average quality, but somewhat anthracitic and is probably much broken by the neighbouring igneous rocks.

(*d*) The Limpopo area in the Northern Transvaal near the Messina Copper Mine. This is a poor grade coal so far as opened up by the Copper Company for its own purposes, but the coal measures are probably extensive, and in such a large area, there may be seams of better quality discovered in the future.

(*c*) The North Waterberg area which is really an extension westwards of (*d*) Limpopo area, which has been mentioned. Here the coal has been found in very thick seams at a very small depth, there being four seams above 130 feet of 5, 7, 10 and 6 feet thickness, another of 22 feet at a depth of 300 feet, and at 330 feet another seam of 13 feet thickness. The lower seams are of ordinary local quality and quite up to the Transvaal quality, while the upper ones are very bituminous and of good coking quality, a fact which may be of great importance in the future.

As mentioned above, however, it is only in district (*a*) High Veldt, that the greater part of the Transvaal coal is being produced to-day and the following table gives analyses of these coals :—

ANALYSES OF TRANSVAAL COALS.*

Name of Colliery.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Calorific value as per Mahler Bomb Process.	Sulphur.
Apex	5.28	17.27	50.00	27.30	9.03	1.14
Bellevue	3.75	31.47	52.40	12.32	12.34	1.50
Breyten	2.75	30.12	50.87	15.06	12.03	1.00
Largo	4.50	24.50	52.00	17.50	10.50	1.50
Middelburg Steam ...	0.94	24.40	60.03	12.02	13.06	1.35
Oogies	3.20	20.90	50.31	13.50	12.57	1.54
Transvaal and Delagoa Bay	1.38	22.38	59.40	15.58	12.50	1.26
Witbank	0.94	27.04	56.06	13.82	13.01	1.24

* Report of Coal Commission, 1921.

This High Veld area in the neighbourhood of Witbank supplies the greater portion of the coal used for ordinary purposes in the Transvaal, e.g., by power companies, railways, mines and works, and it supplies the whole of the bunker export trade of Delagoa Bay Although not equal to the quality of much of the Natal coal, the Transvaal coal has found its way into the Indian and eastern markets, and during the war it secured a footing in places where it has not hitherto been known. The bunker trade has often been adversely affected by the lack of equipment at the Portuguese port of Lourenço Marques, but a more enlightened policy now prevails and it may be accepted that the export trade of the Transvaal will expand rather than diminish. The seams in this portion of the Transvaal are very shallow, and fire-damp is a very rare occurrence owing to the shallow depth of the seams. In some respects these seams are almost too near the surface, and considerable subsidence takes place in many cases as soon as the last of the coal is drawn. Dr. Mellor, formerly of the Geological Survey, wrote an exhaustive account of these occurrences, to which the enquirer may be referred.

As figures show, the Transvaal coalfield, with its natural off-shoot in the Northern Free State just over the Vaal River, is at present and is likely to remain the most important coal producing area of the Union, and the recently

discovered extensions northward appear to make the supplies of this mineral almost inexhaustible. Recent experiments go to show that several of the Transvaal coals are likely to produce a satisfactory coke, a most important consideration in reviewing the future of the coal industry in that province.

Oil Shale and Torbanite.

Considerable attention has been paid in the past few years to the occurrence of oil shale and torbanite, in which the Union appears to be rich, although none of them have been worked Several coal seams also appear to give very high distillates such as nitrogen.

These shales have been shewn to exist over large areas in the Ermelo and Wakkerstroom districts of the Transvaal as well as at Impendhle in Natal Results of laboratory distillation tests are given in Major Trevor's paper "Mineral Wealth of the Union," and several companies have also made exhaustive investigation as to extent, working costs, and values of these shales.

As supplies of natural liquid oils decline, with the increasing demand for oil for all purposes throughout the world, no doubt these shales will ultimately prove remunerative to work.

TABLE II.—COPPER AND TIN IN THE UNION SALES AND SHIPMENTS.

YEAR.	TRANSVAAL		CAPE		UNION OF SOUTH AFRICA.					
	Copper.	Tin	Copper	Tin	Copper			Tin.		
	Tons		Tons	Tons	Tons	Pure Metal	Value	Tons	% of Pure Metal	Value £
1915	14,996	3,401	13,073	39	28,069	43.01	1,012,314	3,441	66.94	331,420
1916	12,242	3,235	10,598	29	22,841	46.06	1,137,380	3,264	66.16	339,571
1917	9,606	2,640	10,525	38	20,131	49.40	1,126,040	2,678	66.80	346,016
1918	5,205	2,190	1,669	15	6,874		342,105	2,206	72.16	440,995
1919	4,609	1,598	275	31	4,885		234,445	1,630	76.24	277,925
1920	2,988	2,452	7,892	10	10,880		418,200	2,463	69.54	435,680
1921	45	1,415	112		157		6,446	1,424	64.50	139,688
1922	--	612	705		705	93	38,622	612	68.16	59,987
1923	6,612	1,420	2,846		9,458	71	404,511	,424	66.73	170,330
1924	6,574	2,051	3,384		9,958	89	530,824	,051	65.91	305,396
1925	6,966	1,938	2,995		9,962	90.15	514,219	,938	65.92	304,557
1926	5,961	1,784	3.274		9,235	98.85	194,852	,791	67.65	310,898
1927	7,897	1,928	2,909		10,806	99.34	577,119	,928	67.06	329,942
1928	7,070	1,992	2,801		9,872	99.47	603,243	,992	67.47	268,618

Copper. (Table II.)

Next in importance to coal come the minerals, copper and tin. The iron ores and the development of a steel industry have already been dealt with in a recent paper read before the Royal Society of Arts, by Dr. Van der Bÿl, who was chairman of the Electricity Commission of the Union, and is at present connected with the Government scheme for the building up of a steel industry. With

regard to the prospects of this scheme and the possible markets for its output, I will, therefore say nothing now.

The most famous of the South African copper mines have been those of Namaqualand, where the Cape Copper Company and the Namaqua Copper Company produced copper with great regularity from about 1864 and 1887 respectively, up to 1918, when the price of copper fell heavily after the war.

The former Company's mines at O'okiep and Nababeep, and the latter's at Tweefontein and Concordia have returned enormous profits over this period. The Cape Copper Company returned some £4,500,000 to its shareholders, while the Namaqua Company has distributed over 400 per cent. in dividends before the war. A visit to these mines is well worth making. Situated on the central range of Namaqualand, 60 to 80 miles inland from the Western coastline, they can be approached from the somewhat precarious roadstead euphemistically called Port Nolloth, or by car from Cape Town—usually a two days' journey over rough country. By either route a very arid country has to be crossed, the rainfall being about the lowest in the Union—2 inches at Port Nolloth—though a little more along the Central Hill range in which the copper mines are situated. Sea fog due to the cold antarctic current up this coast is about the only form of moisture on which the scanty scrub subsists. Occasionally a Northwest winter gale penetrates into the Namaqua range and gives a day or two's welcome downpour, and within two or three days the whole wilderness springs into a magic carpet of wild flowers, which covers it between the huge rock outcrops with incredible patches of yellow, purple, red and blue.

But with its peculiar charm few districts offer such poor facilities for mining; there is no timber, little water, and labour is scarce; and a tribute must be paid to the enterprise and persistence of the two companies I have mentioned. It was the Cape Copper Company which built the narrow gauge railway to Port Nolloth which has hauled up vast tonnages of machinery, fuel and stores, and brought down the ore for shipment. Here again at Port Nolloth, everything had to be handled by lighters towed out through the entrance in the reef to ships lying in the roadstead, shrouded four days out of five in dense fog and pitching and rolling to the heavy swell which rolls up almost incessantly out of vast spaces of the South Atlantic.

The country rock in which the Namaqualand deposits occur is massive gneiss. The ore occurs in dykes of various intrusive rocks, mica-diorite at Ookiep, hypersthenite at Nababeep mine, and norite at Tweefontein—all of which tend to run into the gneiss and make the task of following the ore-body one of considerable difficulty, to which, however, the sharp eyes of the Cape boys are quite equal.

The ore occurred in a series of lenticular bodies in the gneiss, oval shaped and disappearing in depth into thin leaders, which again opened out into further ore masses; but each one smaller than the last, until the deepest became little larger than an office table. The whole character of deposit was laid bare in the

workings of the great O'okiep mine, where the vast stope cavities of the upper ore bodies gave place in depth to smaller and ever smaller excavations, until at last in the bottom scarcely a trickle of bornite could be seen. It would seem as if the ore deposition took place in increasing richness as it rose towards the surface and superincumbent pressures became less. The paying zones have practically cut out at 600 feet in O'okiep and Nababeep, although at Tweefontein ore has been extracted down to just under the 1,000ft. level. The stopes in the O'okiep mine are 70 to 80 feet across and as high as 120 feet, and when lighted up by men working far up their sides, form a magnificent underground spectacle, comparable with the great stopes in the old Great Laxey mine in the Isle of Man, and with those in the old Dolcoath in Cornwall, and with the Sheba in the Barberton district.

Many prospectors hold that a rich outcrop necessarily means good or better ore at lower depths, their slogan being " it must have come from down below, so there must be more if you sink to it," a line of argument which has proved very fallacious in the case of many promising outcrops of gold-bearing quartz reefs in the Transvaal and elsewhere.

Considerable tonnages of lower grade ores still remain to be worked, though the pristine glory is departed. Modern smelting plants have now been erected at all these mines with, as the figures show, a resulting increase in the percentage of ore exported. Development in Namaqualand to-day depends rather on the recent rich alluvial diamond finds in the coast belt and toward the Orange River Mouth. That strange mountain mass of the Richtersveld still calls to the adventurous and may yet yield some valuable copper ores

The other famous copper mine of the Union is the Messina in the Northern Transvaal close to that other great river, the Limpopo. Very different are the scenic and meteorological conditions there. A vast grassy plain slopes northward to the river, formerly full of big game, malaria and Baobab trees. Now the game is disappearing—though a lion may still be met with when you are not expecting one—the malaria is being driven out by the efforts of the management under the enlightened administration of the Manager, Mr. Emery, and the Baobab trees are being exploited by a commercial company, while the old-fashioned waggon transport is now replaced by direct railway communication with the South.

The mine has been developed upon the site of a number of old workings, which first attracted the attention of capital after the Boer War. A mining lease was granted by the Transvaal Government, the area being situated in Crown lands. Production commenced in 1906 and increased steadily until 1916, when it began to fall, with the fall in the price of copper. After a considerable struggle owing to the low price obtainable, the mine shut down in 1921-22, when the Namaqua mines were in the same condition, though operations were resumed by 1923, and the mine has been producing an average of 6,000 tons per annum since then.

The tonnage, percentage of copper and value from the Cape and Transvaal mines respectively since 1915 are given in Table II (page 720), in which similar figures for tin are given.

The Messina ore occurs in a series of veins, which, though somewhat uncertain in value, are showing on the whole better in depth at some places than at the surface. The ore occurs in lenses in a zone of fractured gneisses, which form the country rock. This zone extends roughly for nearly 20 miles, and varies in width up to 300 feet. The bigger lenses are in the higher levels, but in the lower levels down to 1,300 feet, the ore is still present though more disseminated. The lenses occur so irregularly in the fracture zone that the results of development are very uncertain.

Copper has been found elsewhere in the Union in quartz veins in Hay Gordonia and Prieska, and at Insizwa in the Mount Ayliff district of East Griqualand, in this case associated with nickel and a certain amount of platinum None of these have been developed commercially, but the last-named is a particularly interesting occurrence, dipping in under the great escarpment of the remote Insizwa Mountain.

A word must be said of the copper occurrences in that curious land, South West Africa. While extensive traces of copper are found all the way from the Orange River through the arid plateaux, and the stunted bush of the Northern Hills to Tsumeb, actual mining has only taken place in recent years at the latter place, in the Grootfontein valley, and in the desert mine of Khan. The latter with a huge and valuable plant, has not been able to produce copper at sufficiently low cost to survive the period of low prices.

The great Tsumeb mine with its huge mineral body and its complex ore, including copper, lead, zinc and silver, has produced some of the most wonderful individual specimens of various ores of copper to be seen anywhere. The exports from here and the neighbouring smaller workings have varied from 30,000 to 45,000 tons per year, and the whole of this ore used to go to Perthambry near New York for smelting.

While the Namaqua mines to the South have been largely worked by labour recruited from the immediate neighbourhood, and the Namaquas have proved themselves singularly efficient underground men, the Tsumeb mines have had to rely largely on labour imported from the Northern tribe of Ovambos, north of the Kunene. Efficient labour will probably always be one of the main difficulties which mining will have to contend with in South West Africa, the other two being transport and scarcity of water.

At the Messina mine an experiment was made with white labour on development work in place of the Kaffir gangs. Young white men of good physique were recruited locally at a fixed rate plus bonus for footage drilled. These men were employed in each place with two drills, and they fetch and carry their own drills. Some of these men turned out well.

TIN. (*v.* Table II.)

It is not a little astonishing, considering the army of energetic prospectors, who have for years scoured the Transvaal looking for gold, that tin was only discovered first in 1904. Cassiterite has now been found over a large area of the Bushveld, some 250 miles from East to West and about 100 miles from North to South, in the granites, and the felsites and sedimentary rocks at the contacts. The tin is found in joints and bedding planes and is very irregular. At Rooiberg and Leeuwpoort and Zaaiplaats successful mines have been developed which have produced regularly and have made the Transvaal one of the accepted tin-producers of the world. The tin is exported to the Straits Settlements where the best market exists. All these mines have had serious difficulties to contend with in the very irregular character of the tin deposits. At Zaaiplaats the miner has to follow a series of small trickling leads which run into larger pipes or lenticular bodies of rich cassiterite, which pinch in and out with the utmost irregularity. At Rooiberg the mineral is in vertical fissure veins with lateral enrichments passing into the country rock of remarkable value but tending to decrease in depth, all the richer values having been obtained within 100 feet of the surface. At Leeuwpoort the veins are flatter and richer, but the tin does not run into the country rock in the same way. It is interesting to note that these areas have been extensively worked for tin in the past, and that the ancient workings led to the discovery of the present mines. Who these workers were nobody knows—the present South African peoples known to us, having no knowledge of the working or use of tin.

The peculiarity of the Zaaiplaats ore occurrences is that they occur in irregular pipes or tubes wandering through the massive granite at all angles and in all directions, without any recognizable general trend of direction or dip. The cassiterite often appears like an eye on the surface from which it opens out and pinches and opens out again into massive cassiterite. There is often a casing of tourmaline, hard and well defined and disappearing gradually into the country granite. A large number of minerals are found in some of these pipes—mispichol, pyrites, scheelite, nolgranite, magnelite, molybdenite, galena, zincblende and fluorspar.

One of the longest and most productive pipes at Zaaiplaats has been followed for over 3,000 feet and in places gave a section of over 20 feet of solid tin-stone.

In the Eastern Transvaal and Swaziland, on the other hand, a fairly large alluvial tin field occurs, caused by the denudation of the pegmatites in the older granites. Owing to the heavy rainfall and the mountainous character of the country and the consequent concentration of the detritus, working is carried on by the comparatively simple and old-fashioned method of hydraulicing and sluicing. It is said that this ore is remarkably free from impurities. The export is about 300 tons per annum, and at present rates of working these deposits should last many years.

In the Cape, cassiterite has been found in small quantities in the Kuils River district between Stellenbosch and Cape Town in small lodes considerably broken in the local granites. A certain amount of alluvial has been worked in the valley, but the amounts of tin actually shipped have been small, some 600 tons in all.

In South West Africa there is a very distinct zone of tin country running East and West of the remarkable granite mass of the Erongo Mountains, which form such a picture going northward from Karibib. There is another east of the Brand Mountains, and a third near Neineis. The output is steadily increasing, and it is possible that some rich discoveries in connection with the pegmatites may yet be made. The great difficulties are, of course, high transport and living charges, and lack of water.

The figures of Union exports of tin are given in Table II.

Of the remaining minerals produced in South Africa, commercially the more important are :—

Chrome Ore	about	£25,000	worth per annum.
Asbestos	,,	£340,000	,, ,, ,,
Corundum	,,	£10 to 40,000	,, ,, ,,
Soda	,,	£30,000	,, ,, ,,
Lime	,,	£210,000	,, ,, ,,
Salt	,,	£140,000	,, ,, ,,

From time to time galena, antimony, arsenic, iron pyrites, tungsten, manganese and graphite have shewn considerable export figures but are just now at low water level.

Certain minerals show a small but regular production and being of good quality with considerable reserves, are likely to add to the export totals considerably in future years. I refer to magnesite, mica and talc.

To give a few particulars of the more important :—

Chromite has been found to be widely distributed in what is known as the Bushveld Igneoues Complex, North of Pretoria, in the lower portion of the Norites, and have been traced through the Lydenburg and Rustenburg districts over a large extent of country. The chromite varies in thickness from six inches to six feet, but the occurrences are irregular and need careful following up in depth, as the dip varies very greatly, and a'ong the strike. The chromic oxide content varies from 28 to 50%, the average being about 40%. In the Lydenburg area where the largest bodies occur the average is from 42 to 46%.

This ore has a larger content of ferrous oxide than the Rhodesian chromite. It is doubtful whether this should be considered a disadvantage for the making of ferro-chrome.

The Lydenburg ore can be delivered f.o.r. at Delagoa Bay at 35s. per long ton, and with the large reserves available an ever increasing export of this mineral is likely from the Transvaal.

TABLE III.—OTHER METALS AND MINERALS OF THE UNION—SALES VALUES.

Year.		Antimony. £	Arsenic. £	Bismuth. £	Chrom Ore. £		Lead.	Manganese.	Nickel. £	Vanadium £	Tungsten £	Zinc.
1915	...	2,105	—	—	—	—	1,836	—	38			2,214
1916	...	15,292	—	—	—	—	5,202	—			252	
1917	...	12,428	—	—	—	—	3,761	641			1,551	
1918	...	2,589	1,759	—	—	2,720	1,886	1,965			3,647	
1919	...	556	663	300	—	1,081	4,973	776			699	
1920	...	—	655	—	—	811	5,270	277				15,614
1921	...	—	120	—	400	680	3,393	866				8,410
1922	...	—	105	—	108	893	94,720	240				
1923	...	—	290	—	—	230	133,573	1,584		2,716		
1924	...	—	4,260	—	2,446	—	153,288	1,300				
1925	...	—	790	—	21,001	—	55,966	817				
1926	...	—	122	—	14,623	16,958	5,726	744				
1927	...	—	1,336	—	24,939	29,686	7 543	345				
1928	...	—	528	—	35,265	7,486	571	—				

Year.	Asbestos £	Corundum. £	Graphite £	Iron Pyrite £	Kaolin £	Magnesite £	Mica £	Mineral Paints	Soda £	Talc £	Total £
1915	35,899	480	1,204	939	10	1,568	150		20,949	218	67,610
1916	83,070		1,780	8,019	..	1,766	1,185	45	25,121	586	150,080
1917	87,364	13,038	2,590	4,463	19	2,050	877	305	29,377	1,962	160,426
1918	54,037	26,260	2,294	7,002		2,184	1,185	1,427	11,099	1,713	121,776
1919	66,426	1,486	2,630	8,894		2,723	309	572	753	2,170	95,071
1920	114,195	1,446	2,339	5,014		3,786	500	1,049	—	2,227	153,177
1921	103,067	770	1,496	6,632		3,581	802	333	4,527	1,306	136,362
1922	81,230	15,492	1,250	4,714	20	2,372	664	636	1,588	1,023	205,061
1923	121,453	22,543	1,837	4,906	40	2,943	1,038	468	1,018	1,065	295,704
1924	110,075	13,284	1,597	3,109		4,159	2,296	634	9,844	1,592	307,884
1925	152,115	13,229	1,510	3,400		4,007	4,577	..	13,480	262	271,154
1926	216,466	44,871	1,575	3,376		4,211	2,069	607	22,970	385	335,603
1927	343,301	8,473	2,027	3,091		3,935	3,754	1,897	32,710	2,740	465,777
1928	399,550	12,696	1,670	0,087		3,161	8,422	357	30,127	3,993	510,433

Asbestos.—The most interesting, the most widely distributed and the most valuable of the Union's non-metallic minerals is undoubtedly asbestos.

The Cape blue or crocidolite variety has been worked commercially in the Cape Province since the early nineties, though specimens of it used to reach this country long before that.

The increasing use of asbestos for all purposes where non-combustible and heat resisting material is required has resulted in an ever increasing output in the Union of this and the other varieties.

The chief varieties available in the Union are thus summarized by Hall :—

(1) Chrysotile or White Asbestos—the well-known and valuable hydrated silicate of magnesia—Transvaal and Natal.

(2) Crocidolite or Cape "blue," a lavender blue ferrous silicate hornblende—Cape and Transvaal.

(3) Amosite, an ash grey ferrous silicate hornblende—Transvaal.

(4) "Asbestic," so-called a mass fibre variety of anthophyllite—Transvaal.

(5) Tremolite, silicate of lime—Natal.

(1) *Chrysotile.* The best known occurrences are East of Carolina, and in the Kaapsche Hoep District of Barbarton.

The former is not yet important commercially but the latter, lying in a serpentine belt running underneath the Quarzitas of the great Drakensburg escarpment, which includes the picturesque and dominating kranzes of Kaapsche Hoep itself, is being actively exploited by the New Amianthus and other companies.

The working at the Amianthus is by adits, driven 70 feet apart, extending down to about 350 feet.

The fibre from what is known as the Ribbon Line is of excellent quality and is now well established commercially, and several grades are regularly turned out.

A	...	...	...	...	...	over $1\frac{1}{8}$ inches.
B	...	...	...	...	...	$\frac{3}{4}$ to $1\frac{1}{8}$ inches.
E	...	...	...	...	...	$\frac{1}{2}$ inch upwards
F	...	...	...	...	...	$\frac{1}{4}$ to $\frac{1}{2}$ inch.
G	...	...	...	...	...	$\frac{1}{8}$ to $\frac{1}{4}$ inch.

The last two are prepared by milling, A and B by hand-cobbing, while E is prepared by a combined treatment.

The large number of seams, the superior quality of fibre and the ease with which the fibre is detached make this a potentially valuable discovery, and ensure low working costs.

The other companies are working on an eastern extension of these fibre veins in the same serpentine and they are quoting fibre up to two inches.

The chrysotile occurrence in Natal is situated in the Tugela valley and although the ruling length of fibre is less ($\frac{1}{4}$ to $\frac{1}{2}$ inch), it appears to be of very good quality, but so far it has only been worked at intervals.

(2) *Crocidotile.*—The large exploited Cape occurrences are situated in the banded ironstones of the Lower Griqua Town series, from south of the Orange River, northward right through Kuruman into British Bechuanaland, a distance of some 300 miles with a width roughly of 30 miles. As Hall says : "it is the most extensive stretch of asbestos bearing formation known." The present production which is from a variety of places is capable of almost indefinite expansion.

The southern section astride the Orange River has been developed by the Cape Asbestos Company with headquarters at Koragas, 35 miles north west of Prieska, their most famous mine being that at Westerberg where working has gone down to over 250 feet.

Generally speaking, the method of working especially in the northern section has been by the very old fashioned and simple method of open-cast, the work being carried on entirely by natives under their own initiative and in their own way. This way is generally wasteful, slow and uneconomic, but the combined output from a number of small workings becomes considerable.

Grading is based as usual on length of fibre and is as follows : -

X	up to $\frac{1}{4}$ inch.
S	$\frac{1}{4}$ to $\frac{1}{2}$
A	$\frac{1}{2}$ to $\frac{3}{4}$
B	$\frac{3}{4}$ to $1\frac{1}{4}$
C	$1\frac{1}{4}$ to $1\frac{3}{4}$
D	$1\frac{1}{2}$ to 2
E	over 2 inches.

The larger fibre from B to E is hand graded, the shorter grades are machine graded.

Two distinct sets of interbedded seams exist on Westerberg, each made up of from 3 to 7 parallel seams ; they always occur as cross-fibre seams interbedded in the banded ironstones. At over 200 feet these ironstones become softer, but there is no deterioration in fibre quality.

In the Transvaal the crocidolite is restricted to the north east in the southern portion of the picturesque and beautiful mountain country of the old Haenertsburg goldfields, some 60 miles from Pietersburg. The seams are interbedded in the lower sections of the Pretoria series close to the dolomite. They are in ferruginan slates very like the Cape banded ironstone. They have only been opened up in recent years, but are capable of considerable development.

The crocidolite variety differs from the crysotile in that it is credited with higher efficiency as an insulating material, both as regards heat and electricity, and with being unaffected by ordinary acids and chemical solutions, as well as by sea-water. On the other hand the chrysotile offers greater resistance to very high temperatures, and is softer and therefore more easily dealt with in milling and reduction.

(3) *Amosite.*—The crocidolite fibre mined at the famous mine at Penge shows remarkable lengths up to between four and seven inches, a virtue which has been anything but an advantage, as it proved too long for existing plants, and had to be cut to suit the market. This fibre is higher in iron than the ordinary variety, and contains very little soda. It was discovered in 1907, and has been worked in the Penge mine down to a depth of over 400 feet. Its name was given to it from the initial letters of the "Asbestos Mines of South Africa."

The Egnep and Amosa mines are the chief producers, and very large quantities of this asbestos have been opened up. There are three groups of deposit each consisting of several parallel seams occurring with the utmost regularity—a rare thing in asbestos deposits so that it has been possible to lay out the mine working with a regular system of drives and levels. The fibre maintains its length over long distances enabling a regular standard of over six inches to be kept.

The quality of amosite differs considerably from any other form of asbestos. The mineral is certainly rough and harsh to the touch but has great tensile strength and is to a certain extent elastic, quite a peculiar feature. The market for this fibre is bound to extend as its qualities become better known in Europe and America.

(4) *Asbestic* is a mass fibre hornblende associated with certain basic igneous rocks on the farm Korea about fifty miles west of Waterfoort siding on the Messina line. It forms a valuable insulator when mixed with magnesia, and is made up for boiler lagging. Though not suitable for spinning it is suitable for manufacture into sheets and building material mixed with cement or magnesia. As large quantities are available and mining costs are low there should be a good market for this variety.

(5) *Tremolite.* This mineral is found in Zululand about 50 miles from Dundee. The deposit is in green talcose rocks, and is a pale greenish grey to whitish. A certain amount has been worked up into asbestos stone bricks, boiler lagging and for steam packing, but the amounts produced have not as yet been large.

It is interesting to note that whereas previous to 1920 practically the whole output of asbestos from the Union came from the Cape Province, since that date the discoveries referred to in the Transvaal have placed that Province in the leading position and in recent years the Transvaal has been producing at the rate of over 10,000 tons per annum.

Corundum.—No mining industry in the Union has suffered so severely from want of organization and co-operation between producers as that of corundum. Hand to mouth methods, laxity and irregularity in grading and want of capital to enable producers to finance their exports have told their own tale. Figures of export have fluctuated between 123 tons in 1921, and nearly six thousand tons in 1926. World competition and irregular demand in the European and

American markets for abrasives can be blamed to a certain extent, but by n means entirely for the state of the industry.

The corundum is found in the form of large broken crystals in the gneiss and schists of the Zoutpansburg and Barberton districts in the north and north-eastern Transvaal, and has been worked for many years now by the farmers in the former district around Bandolier Kop. The crystals occur in the surface detritus in a gravel about 2 foot thick, and are easily worked by native women and children, and working costs are low.

The parent rock appears to be interbedded in folds of the gneiss. With the exhaustion of the crystal corundum, "boulder corundum" of a compact massive character is found *in situ* running up to 60 per cent corundum. Supplies appear to be unlimited.

The Transvaal Corundum Company and others have made efforts to establish the industry on a sounder basis and to ensure that regularity of output and grading which are essential in securing and keeping any market That those efforts are bound to succeed in time because there is a large and reliable market and an equally large and promising field of supply, there seems to be no doubt.

Soda This is produced from the remarkable occurrence at the crater-like depression known as the Pretoria Salt Pan, a few miles North of Pretoria. The bed of the pan is about 28 acres and consists of a black mud containing masses of trona, or solid crude carbonate of soda The South African Alkali Co. has had a somewhat chequered career owing to difficulties of treatment, but it looks as if now the company had overcome its difficulties and had devised a successful plant.

Lime. Vast areas of the Union are covered by a great thickness of desert lime, and large sections of the Transvaal by the dolomite. It is hardly surprising therefore that the use of local lime is steadily increasing.

The common blue lime for building comes from ordinary kilns burning the magnesian limestone in several districts of the Cape and Transvaal, while white lime for chemical and metallurgical purposes comes also from cave fillings, stalagmitic deposits, etc., in the dolomites. At Taungs a large occurrence is being opened up.

The desert limestone generally contains a considerable amount of silica and other impurities; it is largely worked for making cement in the Free State, and at Pretoria and Mafeking.

The resources of the Union in lime have been carefully surveyed by Mr. Wyburgh of the Geological Survey.

Salt. - There are no known deposits of rock-salt in the Union, but in the more arid stretches of the high veld numerous shallow depressions occur with no outflow, sometimes of several square miles area, from which the waters of the rainy season are rapidly evaporated, with a resulting brine remaining close to and on the surface. Practically all the salt used in the Union comes from the working of these pans, the salt being obtained by solar evaporation in shallow dams.

A few of the larger producers are adopting artificial heat for final precipitation, and this tendency will probably increase. Much of the salt is contaminated by dust carried by the ever present dry winds blowing across the veld. The industry suffers from lack of organization, heavy transport charges and extreme poverty among many of the producers ; but the excessive competition has the advantage of keeping down the price to the consumer. The industry will continue to grow as the Union markets increase, and its resources are pretty well unlimited.

Generally speaking, the base mineral production in the Union is capable of indefinite expansion, but in all cases proper development ahead to ensure regular output, careful grading and care in quality of production, matters which may seem quite commonplace, but which have been too often neglected in the past, are essential to success

As the local markets increase with the development of the natural industries of the country, using the raw materials which are at hand, so it will be possible to study and improve marketing abroad In practically all the minerals referred to above there are large reserves available. I need only instance the recent discovery of large manganese occurrences at Postmasburg, where millions of tons of excellent ore are in evidence It is satisfactory to know that long negotiations have at length been concluded, by which 65 miles of branch railway line is to be constructed to Postmasburg from the branch line at Koop Manstontein, and a company is undertaking the working of these deposits at the rate of 200,000 tons for the first year, and rising to 500,000 tons in subsequent years

Cost of transport is the ever-present difficulty in a vast country like South Africa, where even home markets are remote in point of mileage. Labour remains cheap in spite of increased competition from mines, industries, railways, householders, municipalities, all of which depend with ever-increasing insistence upon the good-natured and ubiquitous Kaffir inhabitant of the Union. Good roads are of the utmost importance in the present stage of the Union's history, to feed the railways, to bridge distances which only the motor car can economically link, and to unite points and communities hitherto remote and perhaps unsympathetic to one another and to the world at large. To none is improved transport more important than to the base mineral producers of the Union.

DISCUSSION.

THE CHAIRMAN said all would have listened with very great interest to the lecturer's able account of the base metal industries of the Union. He was particularly glad that the matter of transport had been emphasised. All who knew South Africa realised what that meant . the distances were so vast ; roads and railways were necessary, and it was essential that the transport should be as cheap as it could feasibly be made There had been a tendency of recent years to go in the

other direction, for reasons which it would be out of place to discuss at the moment, but certainly the question of transport was a matter of the very first importance to the progress of industry in South Africa. The lecturer had confined himself to the Union of South Africa, but, looking beyond to the large areas of South Africa—in Rhodesia, for instance—one found the picture intensified. In Rhodesia, apart from precious metals and stones, there were two products which were of the utmost importance. The production of asbestos in Rhodesia was more than twice that of the Union. If the productions of asbestos of both Rhodesia and South Africa were added together, they came to a very large sum indeed expressed in money. Just to give some slight idea of the importance of that production of asbestos, he might point out that in the year 1927 the production from Canada, which was the biggest asbestos-producing country in the world, had come to 274,000 tons, and its value had been upwards of 10,000,000 dollars or, say, £2,000,000. The South African production had been only 60,000 tons—38,000 tons from Rhodesia and 22,000 tons from the Cape, but the value of it in the aggregate had been much more than half that of the Canadian production, namely, £1,300,000. Whereas the average value of the Canadian production had been about £8 a ton, the average value of the South African production had been £66 per ton. The reason of that was that the lower grades of asbestos were left behind in South Africa; they were not worth the transport, and were discarded, but in Canada the whole of the production was utilised. So that, looked at from the world point of view, Canada stood first, then Rhodesia, then the Union of South Africa, after which followed Russia. The second product which he had in mind was chrome ore. Rhodesia supplied the world with chrome ore. In 1925 she had produced 135,000 tons; in 1926, 181,000 tons and in 1927, 218,000 tons. Going to Northern Rhodesia, at Broken Hill there was the first zinc plant which had ever been worked in South Africa, and although it was on a small scale the deposits were large, and without doubt there would be in the future a very large production. The zinc ores of Broken Hill had also a proportion of vanadium in them—a mineral which, though not mined in great quantity, was of the greatest value. South Africa really supplied the European demand for vanadium. Huge deposits of copper had also been recently opened up in Northern Rhodesia, which would certainly not only have a local interest but a vaster interest from the point of view of the British Empire. Nature dealt lavishly in the matter of minerals with South Africa; she gave with both hands. She did not scatter her gifts of diamonds merely here and there, as in India and in Brazil, but she poured them out, as it were, in buckets full. When she gave gold, she gave it to the Rand in such quantities as to make that district far ahead of any other goldfield in the world in production. So it was with other minerals. There were endless supplies of coal and manganese ores. In Northern Rhodesia there were millions of tons of copper ores which were already proved. In a very few years that country would be a hive of industry. The lecturer had given a most admirable account of the mineral wealth of the country.

MAJOR T. G. TREVOR, A.R.S.M. (Late Inspector of Mines, Union of South Africa) remarked that both before and during the time he had been a servant of the Union his duty had been to push forward the discovery and the mining of minerals. He had always been an optimist, and he was still an optimist; indeed, the only thing he was sorry for was that he had never been optimistic enough. He did not want those who were to attend the meeting of the British Association for the Advancement of Science in South Africa during the coming year, to imagine for one moment that everything which was to be found in the matter of minerals in South Africa

had been found, or that everything which was to be worked there was being worked. The lecturer had mentioned the copper at Messina. That copper at Messina had been found by ancient workers. There were many other ancient workings in the country, one of them very much greater than Messina, and it was not yet known what the ancients got from it, or when they got it. There were other workings where the ancients had presumably worked for specularite. He knew workings which he had measured up in several cases, where over 100,000 tons had been shifted by people who had known their job; and nobody to-day could state what that had been done for. It could only be presumed that it had been specularite, either for decorative or colouring purposes, but it took a good deal to imagine that those enormous quantities could have been used for such purposes. As an example of how long it took to find the value of things, although the manganese deposits to which the Chairman had referred had been mapped years ago by the Geological Survey, not a word had been mentioned then about their being of any possible value, because at that date there had been no probable value. Circumstances had altered since, and now those deposits were of extreme value. There was another deposit, small in size but economically important, namely, fluospar. In one district there was a place where the Boers had used to go for "pretty stones" to put on the graves of their relatives, and all over that district could be seen graves marked with lumps of fluospar. That material was now being worked by an American firm, which was producing a very large output. Then, again, there was copper and nickel in the Bush Veld. A very promising discovery had been made of copper nickel ores in magmatic form. Cobalt deposits, too, had not yet attracted the attention they deserved. It was the same story throughout the whole country. Dr. Hall in 1906 had called attention to the fact that platinum was likely to occur in the Bush Veld, and Dr. Hall and the writer had done their best to persuade people to take it up, but the time then had not been ripe for it. Later on the metal had been discovered by accident by an old alluvial digger digging a watercourse for his potatoes. That was how discoveries happened in South Africa, and was why he asked those who were going there not to think that everything was known about the mineral resources of the country. He himself, in going about the country in past times, had picked up very valuable specimens of radium ores, but had only recently recognised what they were. The whole country was teeming with possibilities of new discoveries.

Major U. P. Swinburne, A.R.S.M. (Late Chief Inspector of Mines, Union of South Africa) said it used to be the custom 40 years ago,—a custom which had perhaps now fallen into disuse—for the best blood of the country in the shape of younger sons, to go abroad out of this congested country and win new lands and possessions. Those lands and possessions had been won by the Englishman for England, but what had happened? The politicians had given them back. Did England own South Africa to-day? Was there any English trade in South Africa to-day? The bulk of the trade was not English. South Africa had been lost to the British Empire. It was said that trade followed the flag. Where was the flag in South Africa to-day? The South African flag was flying a few hundred yards from the present building, easy for everyone to see, but was the flag of England easy to see in that South African flag? Mr. Warington Smyth, Major Trevor and several others present, had been humble musket bearers in the old ranks along with himself of that splendid British administration which had been formed after the Boer War to govern South Africa—an honest English administration at whose head Lord Milner had stood. Where in South Africa were our great administrators to-day? Where was our English trade? What good were all these vast mineral assets to the British

Empire to-day? That was the question to put. Were the people of this country going to continue to allow their younger sons to go out and win lands, and at the same time allow the politicians to give back those lands when they had been won?

SIR RICHARD REDMAYNE, K.C.B. said all present were extremely grateful to the lecturer for having produced such an admirable paper—and, if he might say so, a very timely paper. With regard to coal and oil shale deposits, he would like to ask the lecturer whether the Indwe coalfield in Cape Province was being worked at the present time, or whether it had been entirely abandoned. It produced a very low grade fuel and had been the first coalfield worked in South Africa. The lecturer commented on the high class coal which existed in Natal. He was inclined to join issue with the lecturer in his comparison of it with high class north country coal. There was something more than merely the calorific value which commended a coal. The nature of the ash and the manner in which the coal burned had to be taken into consideration. The ash content of the Natal coal was on the average nearly twice that of north country coal. Some of the Natal coal, which had a high calorific value, had unfortunately an ash which was very fusible, which was very detrimental to use for steam raising purposes, especially at sea. He had been very interested in what the lecturer had said with regard to the effect of the basaltic dykes causing the coal to become anthracitic and imprisoning gas in gas-tight compartments. He had made out a calculation in Natal from a number of bores which he had put down to the effect that if the basaltic overflow was from 150 to 250 ft. in thickness, wherever it approached within 250 ft. vertically of the coal, the latter was always adversely affected. He had seen at the same time the extraordinary phenomenon of a dyke traversing a coal seam and leaving it unaltered, and not many yards away another dyke which had altered it completely for yards. It was a phenomenon very difficult to account for. There was an interesting thing about the nature of the gas. The gas—which he did not think was the characteristic of marsh gas as developed in British coalfields—seemed to contain helium. If that was so it might be that that was another influence brought about by the dykes.

With regard to the oil shales, he would like to inquire as to the sulphur content. There were very extensive oil shale deposits in this country—in Norfolk, for instance—which were practically valueless although they gave a very good oil return on distillation. The oil was so sulphurous that it was worthless. It would be interesting if the lecturer could give any information on that point. He would also be obliged if the lecturer could give any information as to the possible commercial value of the recent remarkable discovery of radium ore at Gordonia, in the north-west of Cape Province.

DR. W. KUPFERBURGER, said he appreciated the lecture because there was no one else who was in a better position to talk about the subject than the lecturer. There were a few points with regard to the grading of these minerals which were of particular interest to himself, and he pointed to the example of the grading in the case of the coal exports of South Africa, first of all in Natal and later on, established by legislation, in the Transvaal. In the case of the minor base minerals such as asbestos and mica, there had been various difficulties about the marketing in England and on the continent of America. To a large extent those difficulties had been due to a lack of knowledge of the markets, and also partly to the ignorance and perhaps the inability of the producers in South Africa to produce and deliver the goods over a continuous period. With the exception of

asbestos, which was now a well-established industry, most of the other minor minerals were worked by small miners, who eked out a precarious existence and worked spasmodically and not over continuous periods. During the last year or two he had been studying the matter of marketing those minerals, and there was at present a conscious effort being made in South Africa to regulate and control the sale and exportation of those minor minerals on similar lines to the coal business. A Bill had recently been enacted which made provision for the Government regulation of some of those minor minerals. At present those provisions had only been worked out and applied to the export of corundum, with very good results, and they might be extended to some of the other minerals as occasion demanded. His impression was that in South Africa they were trying to live down the rather unwelcome epithet which used to be applied to South Africa, namely, that it was a land of samples. Provision was being made so that the quality of the minerals exported would be guaranteed.

MR. WARINGTON SMYTH, in reply, said he agreed with the last speaker that efforts were being made to deal with the question of grading. Parliament had seen the necessity of doing something in that direction. With regard to the questions raised by Sir Richard Redmayne, he understood that a certain tonnage was still being produced from Indwe Colliery, but it did not exceed 5,000 tons a year. The discussion with regard to Natal coal qualities was one which was perennial. There had been so many opinions expressed that it was a most dangerous subject to enter upon; in fact it was just as gaseous as the deposits of coal themselves, and nobody should enter upon it with a naked light! Sir Richard had tried to start a spark in it that afternoon! With regard to the influence of dykes on the seams, a man like Steart, who had been in the Geological Survey, would be able to keep the audience interested the whole afternoon by giving the results of the effects of those dykes as observed on the coal, and by describing the conditions which had been found in some of those gas-tight compartments under those overflow sheets. The interferences were very strange and very unequal. It was an interesting subject but a very large one. With regard to oil shales, he had not made that one of his own subjects. Major Trevor had been an enthusiast with regard to oil shales, and some had accused him of being unduly optimistic. Very little was known—at all events not sufficient to enable anybody to pronounce anything definite, and that was why he had skipped over that subject rather lightly in the paper. He could not state what the sulphur content was of those shales, but he would find out. With regard to the recent discovery of radium ore, he was sorry to say he had not information about it sufficient to enable him to pronounce any opinion upon it.

Votes of thanks to the lecturer and to the Chairman having been passed unanimously, the meeting terminated.

OBITUARY.

THE EARL OF ROSEBERY, K.G., K.T.—By the death of the Earl of Rosebery, which took place at his residence, The Durdans, Epsom, on May 21st, the Society has lost not only one of its most distinguished, but also one of its oldest, Fellows. His Lordship was elected a Life Member in 1876, and had thus been on the roll

for fifty-three years; and he served as a Vice-President of the Society and a member of the Council for two periods, 1894–7 and 1909–12.

Full justice has been done to the many-sided brilliance of Lord Rosebery in the obituary notices which have appeared in all the leading newspapers. In statesmanship he held the high offices of Secretary of State for Foreign Affairs and Prime Minister; in literature his works on Napoleon, Cromwell, Pitt and Chatham are regarded as classics; in oratory he was excelled by no one of his time, and in the very different sphere of sport, he was three times winner of the Derby.

JOHN T. MARTEN, M.A., I.C.S.—We regret to announce the death on May 11th, at Juan-les-Pins after a short illness, of Mr. John T. Marten, who was staying there on leave preparatory to retirement from the Indian Civil Service, of which he was a distinguished senior member. Born on September 28th, 1872, he was educated at Clifton and New College, Oxford, and entered the Indian Civil Service in 1896, being posted to the Central Provinces. After serving as Assistant Commissioner and Deputy Commissioner in various districts, he successively filled a number of important positions, being Excise Commissioner in 1906-7, Superintendent of Census for the Central Provinces and Berar from 1909 to 1912, Financial Secretary and Chief Secretary from 1913 to 1916, Inspector-General of Police, 1919, and Census Commissioner for India from 1919 to 1923 In his Census Report on the 1921 census, an able and well-written document, Marten struck out a new line by devoting a considerable amount of attention to the analysis of occupational tendencies. In 1925 he was appointed a member of the Central Provinces Executive Council and two years later he acted as Governor and was made a C.S.I. In 1923 he read a paper before the Society, on "The Indian Census of 1921," and again in 1925, another paper on "Population Problems from the Indian Census."

NOTES ON BOOKS.

CREATIVE EDUCATION AT AN ENGLISH SCHOOL By J H Whitehouse. Cambridge University Press. 16s.

The system of education practised at Bembridge School is deeply interesting. As to its great superiority to the established public school methods there seems no doubt at all. Whether the results are going to be correspondingly great depends, first, on human nature and a variety of adventitious circumstances, secondly—I need hardly say—on the point of view

Just as sending boys to chapel does not necessarily make them religious, so sending them into a studio does not necessarily make them lovers of art. Nor is it ever possible to foresee the result of a conflict, so to speak, of contaminations. When the followers of Wesley became a nuisance to the authorities, many of them were impressed into the army, where it was hoped they would soon be swearing and drinking again with the best. But the wrong germ proved the more hardy, and for the time being the British Army became the worthiest, most edifying body in the country.

The question then is: With regard to Bembridge and similar institutions, will the spirit of art carry the day and purify the public school atmosphere, or will the public school atmosphere prevail and taint the spirit of art? Very reassuring on this head is the tone adopted by Mr. Whitehouse in his book. He writes, in the most natural way in the world, of "values." In my years at one of the three most famous public schools in England I did not once hear from a master that

there were such things as values. In so far as any values were hinted at, they were sham ones; not real values, mere matters of expediency, to which a monstrous importance was in all manner of subtle ways attributed.

But Mr. Whitehouse speaks of "developing the personality;" of "a fuller and richer life;" and he expresses views about individualism beside which the ideals of the ordinary public school sound as false as the nonsense about "service" which we cannot avoid seeing every day in the papers and on the hoardings. That such provincial notions, as a basis for education, should flourish two thousand years after Plato is extraordinary. Bembridge at least sees the individual *sub specie aeternitatis*, and if a Leonardesque versatility is held up as an ideal to the boys, this is less absurd and less dangerous than urging Smith Minor to fancy himself, in anticipation, ruling "imperio populos" and taking Roman measures against the "superbos."

I can very well imagine a critic saying. "Yes, but is this kind of education at Bembridge a fitting preparation for the world? There is not a very large demand for woodcuts, calligraphy and so forth. Nor are the studio and workshop a true microcosm of life as it is. The Bembridge boys will be sadly disillusioned when they leave if they think so."

To which the answer is: "There is an even smaller demand for ability to kick a football and drill a platoon. And in what way do the traditions of a sporting and independent gentry help a boy to travel in oil or adapt himself to the routine of an office? At any rate, the arts, and interest in the arts, are good things in themselves. One can never be disillusioned through having cultivated a contemplative imagination. Disillusionment may well come if one has acquired the outlook and, incipiently, the virtues of a Roman patrician, and, as the son of a comparatively poor professional man, has nothing—neither money nor leisure—with which to support one's pretensions.

For all the feeling there is nowadays about "progress," only a minority can be found to believe that the road to our ends may be an intellectual or psychological one. The majority acquiesce uneasily in the dogma of salvation by increased production. When the young Gladstone was still a Tory he wished the West Indian slaves to be set free, if at all, by a series of elaborate stages. "Such men are born slaves," he might have begun his speeches in the House; and so, for wretched reasons, they were. Likewise it seems to the timid that a short cut to culture must be dangerous for a community steeped in original sin. But it is high time these "si vis pacem para bellum" paradoxes were finally exploded; if we really wish for peace we do not arm to the teeth, and if we want boys to be educated we must not lead them into the camp of Goliath.

The modern man is ingenious and inclined to be humanitarian, what he conspicuously lacks is *taste*, which can alone give him confidence when it comes to selecting the materials for a true civilisation. We acquire taste by training our sensibilities, and this is done most conveniently and satisfactorily by concentrating our attention on one or more of the arts. For this reason the Bembridge methods appear excellent. If practising various arts does not lead the boys to perfection it will anyhow lead them to better appreciation, and make it impossible for them to accept the raw standards of culture which seem quite tolerable to the average public school boy. "The common saying, that tastes are not to be disputed . . . corresponds with the notions of those who consider (taste) as a mere phantom of the imagination, so devoid of substance as to elude all criticism." Sir Joshua Reynolds dealt with this fallacy in his seventh Discourse. Bembridge deals with it also. The fortunes of this school should be carefully watched.

P.B.

GENERAL NOTE.

SUMMER SESSION IN HISTORY OF ART AT PARIS.—The Institute of Art and Archaeology of the University of Paris offers a summer session in the History and Appreciation of Art, opening on July 1st and lasting for seven weeks. The session is open to students, both men and women, of all nationalities. The courses are designed to meet the needs of the following persons. university and college students who expect to specialise in art with a view to becoming teachers of art, curators of museums, architects, art workers, and writers; teachers of art and curators of museums who would like an opportunity to take advanced instruction, acquire new points of view, and study directly the art treasures of France; students or teachers of French or of History particularly interested in Art. The programme comprises six courses: Greek and Roman Antiquity; Medieval Art; The Art of the Renaissance; French Classical Art, French Painting in the XIXth and XXth Centuries; Museum Training. Conducted tours will be arranged to museums and other places of interest. A limited number of rooms at the Cité Universitaire will be reserved for students, while those who prefer to reside with private families can procure lodgings at selected pensions. Circulars giving further information about the session may be obtained by writing to: M. Henri Goy, Head of the Information Office, Sorbonne, Paris (V^e)

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 3..Geographical Society, Lowther Lodge, Kensington Gore, S.W. 4 p.m. Special General Meeting for Revision of Bye-Laws.

Royal Institution, 21, Albemarle Street, W. 5 p.m. General Meeting.

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. P. Karrer, "Organic Chemistry." (Lecture II.)

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Sir Ambrose Fleming, "Nature and the Supernatural."

TUESDAY, JUNE 4..Anthropological Institute, 52, Upper Bedford Place, W.C. 5 p.m. Mr. T. A. Rickard, "The Discovery of Metals"

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7 p.m. Annual General Meeting.

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VI.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. Robin Flower, "Life, History and Folklore of a Kerry Island." (Lecture III.)

WEDNESDAY, JUNE 5..British Commonwealth League, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 10 a.m.

University of London, at the London School of Economics, Houghton Street, W.C. 5 p.m. Dr Hubert Hall, "Some New Aspects of Town and County Life in Medieval and Post Medieval Times."

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Prof. Jules Bloch, "Some Problems of Indo-Aryan Philology." (Lecture I.)

THURSDAY, JUNE 6..British Commonwealth League, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 10 a.m.

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. F. Challenger, L. Klein and T. K. Walker, "The Production of Kojic Acid from Pentoses by *Aspergillus Oryzae*" (2) Messrs. T. M. Lowry and G. Jessop, "The Properties of the Chlorides of Sulphur. Part II · Molecular Extinction-coefficients." (3) Messrs. M. S Lesslie and E. E. Turner, "The Isomerism of Derivatives of 2-Phenylnaphthylene-1 3-diamine." (4) Messrs. T. M Lowry and F. L. Gilbert, "Studies of Valency. Part XIII · Further Experiments on the Molecular Structure and Configuration of the Quadrivalent Derivatives of Tellurium."

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Meyendorff, "The Class-struggle Idea in Current Soviet Legislation and Administration" (Lecture I.)

5.30 p.m. Prof. P. Karrer, "Organic Chemistry." (Lecture III.)

At St. Thomas's Hospital, Albert Embankment, S.E. 5 p.m Prof S. J. Cowell, "Dietetics." (Lecture VI.)

At the School of Oriental Studies, Finsbury Circus, E.C 5.15 p.m. Prof. Jules Bloch, "Some Problems of Indo-Aryan Philology." (Lecture II.)

FRIDAY, JUNE 7 .Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Dr. C. T Onions, "The Supplement."

Royal Institution, 21, Albemarle Street, W. 9 p.m. Mr. C. Leonard Woolley, "Excavations at Ur, 1928-1929."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz." (Lecture I.)

5.30 p.m. Mr. F. H. Marshall, "Capodistrias in Greece."

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Philip Noel Baker, "The Consequences of the Paris Pact for the Renunciation of War." (Lecture I.)

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m Prof. Jules Bloch, "Some Problems of Indo-Aryan Philology." (Lecture III.)

At University College, Gower Street, W.C. 5 p.m. Mr. Arthur Stratton, "French Romanesque Architecture."

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All communications for the Society should be addressed to the Secretary, John Street Adelphi, W.C.(2.)

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

FRIDAY, APRIL 12TH, 1929.

SIR STANLEY REED, K.B.E., LL.D., in the Chair.

THE CHAIRMAN said he did not know exactly what the functions of a Chairman were on such an occasion, except that it was his duty not to stand between the lecturer and his audience. He would content himself, therefore, with saying that they were all exceedingly fortunate in having Mr. Cooper to address them that afternoon on recent electrical developments in India. It had been his good fortune to be associated with Mr. Cooper for some twenty years. During that time he had learned to lean with entire confidence on Mr. Cooper's very high professional qualifications and his very wide experience of electrical problems in India. Without more ado, he would ask Mr. Cooper to be so good as to read his paper.

The following paper was then read:—

RECENT ELECTRICAL PROGRESS IN INDIA.

By A. T. COOPER, M.INST.C.E., M.I.MECH.E., M.I.E.E., M.CONS.E.

Long before the uses of electricity began to enter into the lives of the people of India, monuments to the skill of engineers in the form of water, drainage, and irrigation works had contributed to their health and prosperity, but recently it may well be claimed that, so far as the larger centres of population are concerned, the electrical branch of engineering has played a more intimate part in their lives than any other.

ELECTRICAL IMPORTS.

As a broad indication of electrical progress, statistics of recent imports of electrical machinery and apparatus into India may first be referred to :—

During the past five years the total annual value of imports of Electrical apparatus, machinery and accessories has averaged 5½ crores of rupees (about £4,000,000), and has not varied more than 10 per cent. on either side of that average.

Although this figure includes the cost of replacements of existing articles, which have worn out or become obsolete, it does not include that of the many items of plant and material ancillary to electrical development. Assuming that the addition on the one hand cancels the omission on the other, and bearing in mind the growing tendency to manufacture many small electrical articles in the country, the steadiness of the absorption may be deemed to be indicative of substantial progress.

Dealing with the many applications of electricity it is only right to commence with the senior service.

Telegraphy.

The principal improvements in land line working, which have been introduced by the Government of India Telegraph Department during the last six or seven years, have been in connection with long distance circuits employing high speed printing systems.

The installation of Regenerative Repeaters or Retransmitters has rendered quadruple "up-and-down" working on the Baudot System possible over the longest circuits operated by the department, the lengths of some of which are shown by the following table:

Terminal.	*Distance. Miles.*	*Retransmitting Station.*	*Distance. Miles.*	*Terminal.*
Calcutta	703	Nagpur	521	Bombay
Calcutta	555	Vizagapatam	489	Madras
Calcutta	626	Akyab	446	Rangoon
Madras	347	Madura	379	Colombo

Calcutta—Agra 808 miles and Bombay—Agra 843 miles are worked satisfactorily without any intermediate retransmitting station.

Specially designed Baudot Typewriter keyboards and converted Murray keyboards with tape transmitters have been recently installed on some of the main circuits as a labour saving experiment, and their operation is being closely watched.

On short and less important circuits similar efforts towards savings in labour and plant have been made by the introduction of modern types of concentrator switches and of the composite method of Morse working, while in the large Telegraph Offices Lampson Carriers have been installed for the conveyance of messages to and from the Instrument Tables.

With regard to Radio Telegraphy, stations for point to point working were installed in the Bay of Bengal as early as 1905, and in 1918 there were some 30 stations of the spark type in operation. These have since been fitted

with continuous wave transmitters and receivers employing three-electrode valves.

A high-speed duplex radio service between Madras and Rangoon was opened in 1923, but owing to trouble from atmospherics during the S.W. monsoon it was abandoned in 1926.

The most recent application of radio telegraphy is of outstanding importance. In 1925 the Indian Radio Telegraph Company was floated for the purpose of establishing a system of reciprocal communication between India and Great Britain, and a short wave transmitting beam station at Kirkee near Poona, and a receiving station at Dhond, were officially opened by the Viceroy in July 1927, and come into regular public use two months later.

The British Stations are situated at Grimsby (transmitting) and Skegness (receiving) and are connected by land lines with the G.P.O., London, the Indian Stations being similarly connected with the G.P.O., Bombay.

Under the contract with the Government the Indian beam system was to be capable of sending and receiving at the same time a minimum of 100 words a minute each way over a 12 hour working day, but this minimum was largely exceeded on test when a speed of 130 to 150 words a minute over an 18 to 21 hour stretch was found possible, so that the capacity of the system is estimated at 180,000 words a day in each direction.

The success of the " Empiradio " service was immediate, and the volume of traffic so far exceeded the estimates as to constitute an actual embarassment, for the initial staff engaged was found to be inadequate to deal with it, and some difficulty was experienced in training recruits while at the same time keeping the service in operation.

An extension of the beam system from India to other countries is under negotiation, and developments in this direction are anticipated as soon as the merger between the submarine cable and radio interests has come into active operation.

Further uses for Radio Telegraphy will no doubt be found in India such as navigational direction finding (stations at Karachi, Bombay, and Calcutta having already been installed) and also for communication with Lightships and Police Outposts.

Telephony.

Developments under this head may be broadly divided into two classes :—

I. Those relating to the modernising of old exchange equipment.

II. Those in connection with long-distance working with the aid of Thermionic Repeaters.

Within the last few years a number of automatic exchanges* have been installed by the Government in place of the original manually operated plants. Details are as follows :—

Name of Exchange.	Size. Present Equipment (Circuits).	Ultimate Capacity (Circuits).	Type of Automatic Equipment.
Delhi	1,500	3,000	Peel Conner, Machine Switching.
	1,400	3,000	
Cawnpore	500	2,000	Ditto.
Nagpur	200	500	All-Relay (Relay Automatic Co.).
Poona	500	1,000	Ditto.
Amritsar	700	700	Strowger (Machine switching).
Rawalpindi	500	600	All-Relay (Relay Automatic Co.).
Quetta	300	300	Ditto
Allahabad	220	300	Ditto.
Bengal Coalfields Exchanges (4)	780	2,000	All-Relay (Peel-Conner).
Ootacamund	150	300	Ditto (Relay Automatic Co.)
Conoor	150	300	Ditto
Meerut	80	100	All-Relay (Peel Conner).

Upon the working of these exchanges the Government will shortly be in a position to decide which system of automatic working is best suited to Indian conditions.

The telephone service in the three Presidency Cities, and also in Karachi and Ahmedabad, are in the hands of private companies working under License.

Bombay (9,000 subscribers) and Madras (3,000 subscribers) have both recently changed over to automatic working, but Calcutta (9,000 subscribers) still retains manual operation.

Extensive development in the Government long distance trunk service has recently taken place, and the network is now very comprehensive.

For distances of over 350 miles Thermionic repeaters are used, and the quality of speech transmission is claimed to be good as a rule up to 1,000 miles, but beyond this distance, difficulties in maintaining uninterrupted communication are met with. In the absence of "interruption" or "disturbance," "commercial" speech is sometimes possible between Calcutta and Bombay via Delhi, a distance of 1800 miles, but as compared with Europe and the U.S.A., India is evidently rather backward in long distance Telephony in spite of the urgent need for an efficient service for linking up the ports with the Capital and with industrial centres.

So far no provision for inter-continental telephony has been made, but it forms part of the future programme of the Indian Radio Telegraph Company.

Public Supply of Electrical Energy.

A general supply of electrical energy is now available in all Indian cities of any importance, while many Licenses for supply in the smaller urban centres have recently been granted. In the secondary towns, with few exceptions, oil engines have been utilised as prime movers, while in the larger, apart from Bombay, steam turbines and water tube boilers form the medium for the transformation of thermal into electrical energy.

The demand per head of population varies over wide limits ranging from 5 or 6 units per annum in some of the smaller cities to about 200 in the case of Bombay. Even the latter figure is far below those reached in Europe and America.

The following notes record some recent developments in the principal cities, taking them in the order of relative population of areas of supply :

Calcutta. The demand for electrical energy in this great city has recently increased very rapidly, and energetic steps have had to be taken by the Electric Supply Corporation, under the Chairmanship of Lord Meston, to keep pace with the requirements of their area with its population of one and a half millions.

In 1925 100 million units were sold. Last year this output reached 148 millions while the estimate for the current year is 168 millions. Truly remarkable progress.

The first section of a new Southern Power Station laid out for an ultimate capacity of 150,000 kilowatts came into operation at the end of 1926. This is equipped with stoker-fired water-tube boilers and turbo-alternators generating at 3-phase 6000 volts, circulating water being taken from the river Hooghly.

24,000 kilowatts of plant have so far been installed and a further 15,000 kilowatt set is due for installation this year.

Although this new station was designed more with an eye to high reliability and low maintenance than to spectacular steam results, only 200 lbs. pressure and a total steam temperature of 600° Fahrenheit being utilised, yet its actual performance works out favourably when compared with the modern home stations of the same size and equipped for much higher steam pressures and temperatures, the overall thermal efficiency for last year being in the neighbourhood of 14%, and this in spite of the many tropical disadvantages met with, including circulating water running at times up to 93°F.

The Southern Station is linked up with the older Northern Station at Cossipore by means of two 6,000 volt trunk feeders laid along separate routes.

The leading developments to be noted with regard to the general supply in the city are the recent completion of the transfer of the Tramway Company's load to the Electric Supply Corporation and the substantial progress made in the electrification of the Jute Mills and other large industries.

An interesting recent addition to the distribution system is a large Rotary Substation arranged for an ultimate capacity of nearly 40,000 kilowatts of converter plant. As this is situated in a somewhat critical position in the bazaar it is fully equipped for " siege conditions " during periods of communal disturbances, special window and door protection being arranged, together with provision for rationing and for emergency sleeping quarters for the running staff.

Bombay. The outstanding recent development in connection with the general electric supply in Bombay was the completion of the change-over from a thermal power station to bulk hydro-electric generation. For many

years the Electric Supply and Tramways Company, although owning a large steam power station on the waterside, had taken supply from the Tata Hydro group in outlying districts to avoid the necessity of running out costly feeder mains, and when, owing to the rapid increase in the demand, they came to be faced with the necessity for major extensions to their power station, a contract was entered into with the Hydro Companies for their entire requirements. The change-over necessitated building a large Receiving Station alongside the steam power station. This is fed at 20,000 volts 3-phase from the Tata Receiving Station, and is equipped with 20,000/5500 volt transformers and the necessary switchgear. The change-over of the 5,500 volt feeders to the new receiving station was of necessity a gradual one, but the whole of the load was finally transferred in January 1926, and the power station shut down.

A more recent development in Bombay City has been the decision to deal with the direct current area in the Fort district by means of remote-controlled peak-load rotary converter substations located at strategic points and operated from a central control office. The manual attention to these substations will be restricted to periodical cleaning and overhaul.

As regards the general tendency of public electricity supply in this city, it is interesting to record that the middle-class Indian has not been slow in taking advantage of the domestic amenities which electricity has to offer in the way of refrigerators, water heaters and electric cooking appliances, while the electric *dhobi* is rapidly gaining favour, and the charcoal *sigri* will shortly become a suffocating memory.

The recent decision of the G.I.P. Railway to instal electric cooking apparatus throughout the large restaurant in the new building at their Victoria Terminus constitutes a significant confirmation of the adaptability of this application of electricity to Indian conditions.

The B.B. & C.I., the other railway running into Bombay, have adopted flood-lighting of their administrative block for notifying the arrival of their mail trains at night.

Madras. This third city of India, the "City of distances," with its 27 square miles of municipal area, and 300 miles of thoroughfares, is supplied with electrical energy on the same lines as those obtaining in Bombay and Calcutta, i.e. Direct Current in the centre and Alternating Current in the outskirts.

The Madras climate, which has been described as "three months hot and nine months hotter," calls for the continuous use of electric fans which, while contributing to the satisfactory annual load factor of 45 per cent., have been recently utilised as a means of improving the power factor of the Alternating Current System. Condensers have been incorporated with all fan regulators, bringing the system power factor up to .95 and sometimes to the neighbourhood of unity.

Delhi. Although the capital city of British India and fourth in order of population, the electric supply arrangements in Delhi call for little comment.

An English Company has for many years dealt with the public supply in the old city from an oil engine plant, while the requirements of the new Imperial City and the cantonments are derived from a small steam power station put down by the Government in 1925 equipped partly with old and partly with new generating plant, transmission being at 6600 volts 3-phase with distribution on the direct current system. As the aggregate generating capacity of the two undertakings is only 6000 kilowatts, it is to be regretted that no combination of interests was found possible.

Lahore. This city is now supplied by the local company on modern lines from a new Steam Turbine Station with 3-phase generation and 6000 volt underground transmission to rotary and static substations. Over 9,000 consumers are connected and the annual consumption is about 5 million units.

As Lahore is shortly destined to become the terminal station of the long distance transmission from the Mandi hydro-electric installation referred to later its supply of electrical energy appears to be well assured.

Ahmedabad. Considering its population of only 200,000 Ahmedabad may claim to be one of the most industrialised cities in India, but although it possesses nearly 100 textile mills, it is only recently that a general power supply has been seriously contemplated.

The successful local electric supply company with its Diesel driven plant has not been in a position to cater for large blocks of industrial load, and some of the more enlightened mill-owners have installed their own generating stations in order to obtain the manifold advantages of the electric drive.

Last year, however, the Ahmedabad Power Electric License was granted authorising the supply to industrial users, and it is hoped that if sufficient support is forthcoming a concrete scheme may shortly be prepared. In view of the condensed nature of the industrial area on the one hand, and the comparatively low average individual capacity of the mills, viz: 700 H.P. on the other, there is evidently an opening for a successful power undertaking.

Karachi. Although at present it stands ninth in the list of Indian cities as regards population, Karachi has a great future before it not only as a maritime but also as an air port, and the local Electric Supply Corporation has been fully alive to the necessity of providing for the future.

In 1924 a 6600 volt 3-phase power station was built alongside the old direct current plant in order to enable outlying areas to be dealt with, and several schemes are projected for throwing over the load of small private generating plants on to the public distribution system.

Diesel type prime movers are used throughout.

The fact that the supply Corporation's output has doubled in the last five years is indicative of rapid progress, and energetic management.

Cawnpore. No outstanding recent technical developments can be recorded in connection with the electric supply system of Cawnpore (which apart from the Presidency cities may be looked upon as the pioneer system in British India,

general supply having been started on Christmas day 1906), yet attention must be called to the rapidity with which demand has been fostered during the past few years by the far-sighted administration of the Cawnpore Electric Supply Corporation.

Following the laying down of a new riverside power station in 1921, the consumption of electrical energy has increased nearly fivefold, from 5½ million units in 1922 to 27 millions in 1928; while the average receipts per unit sold have been lowered during that period from 2.62 annas to 1.26 anna. Apart from the ordinary domestic supply, cotton, flour, oil and woollen mills are the principal consumers.

Aden. Although this paper is only intended to cover the Indian Peninsula, and no attempt is made to deal with Burma and the numerous outlying Islands and Dependencies which fall within the Indian Empire, it may perhaps be permitted (as the writer had a hand in the scheme) to make reference to the electric supply undertaking at Aden, which, although 1600 miles from the Indian coast, is yet included, from an administrative point of view, in the Bombay Presidency.

This arid " Gibraltar of the East " had long craved for the amenities which electricity can provide, and under the aegis of the Settlement (or Municipality) a general supply was inaugurated in February, 1926. An installation comprising oil-fired water-tube boilers and small geared turbo-alternators arranged as a miniature replica of a large modern steam power station now supplies the Settlement and Cantonments through 6600 volt 3-phase over-head lines stepped down to 3 by 230 volts by transformers located in the bases of special transmission towers.

The undertaking secured immediate support, and the initial outlay having been cut down to a minimum, the results for 1928, the third year of working show a substantial surplus after paying all interest and sinking fund charges on a total capital expenditure of 11¾ lakhs of rupees.

Electricity in the Indian States.

One third of the total area of India, containing a fifth of its population, is ruled over by hundreds of Indian Princes having their own internal governments.

Many of these rulers have been quick to appreciate the advantages of the use of electrical energy and possess up-to-date installations for its generation and distribution. A few recent developments may be briefly described :—

Hyderabad. The Nizam's Government early recognised the value of electricity supply in the capital city, and dealt with its initial lighting requirements by means of a small steam-driven installation located in the Mint. The demand, however, rapidly outgrew this plant, and a few years ago a new power station built on a rocky promontory in the Hussain Sagar Lake came into operation. This is equipped with " unit " coal pulverisers, water-tube boilers, and 6600 volt 3-phase turbo-alternators. The lake water is circulated for condensing purposes.

A general supply is given for public and private lighting in Hyderabad City, and also in the British Cantonment of Secunderabad a few miles away.

Although there are several other towns of importance in the Nizam's broad dominion, only one of them (Aurungabad) has yet been equipped with a general system of electrical distribution.

Indore is about to put down a new power station in the heart of the industrial area of the city in which there are nine cotton mills and sundry other industries. This will generate 3-phase energy at 6600 volts and the initial plant will be oil-engine driven on account of the difficulty in obtaining sufficient water for steam operation. Mr. Palairet, the Minister responsible, estimates that a 10,000 k.w. plant will be necessary in a few years' time.

Travancore State has just instituted an electric supply undertaking at a cost of over Rs. 4 lakhs for supplying the capital, while four small water power plants are in operation in the tea districts.

Jaipur State in 1926 put down an up-to-date oil-engine driven power house and a complete system of underground mains in the city for street lighting and general supply.

Udaipur is about to instal a small steam power house for palace lighting and general supply.

Hydro-Electric Developments.

Mr. J. W. Meares, in the paper which he read before you in 1922, described the arduous work which had been carried out by him and his colleagues in connection with the location and assessment of the water power resources of India, and the schemes which had at that date been carried out.

Since then three outstanding projects have presented themselves for record :—

The Tata Power Company. This Company's scheme forms the third section of the development of water power in the Western Ghats for transmission to Bombay City and its environs, so courageously undertaken by the firm of Tata & Sons. The first two sections, viz : those of the Tata Hydro-Electric and the Andhra Valley Companies were dealt with in the paper presented to you by Mr. Alfred Dickinson in 1918. The triple installation is perhaps almost unique, inasmuch as energy is entirely derived from rainfall averaging 200 inches a year and stored within the actual catchment areas. Electric supply must, therefore, be sold by the kilowatt-hour as in the case of thermal power stations, whereas undertakings deriving their power from the harnessing of rivers can enter into contracts for supply on the basis of the kilowatt-year, as the flow continues whether transformed into electrical energy or not.

The combined output of the three undertakings according to the latest available figures is 280 million units per annum, and the maximum joint load so far recorded on the power houses 120,000 Kilowatts, i.e. less than two-thirds the installed plant capacity, while an annual load factor of only 25% is revealed. The Bombay mill troubles must be blamed for the poor load

factor, but it is evident that additional outlets for the power supply must be sought before this important combination is loaded up to a favourable economic level, carrying as it does an average capitalisation of about Rs.825 per kilowatt of installed generating capacity.

The salient features of the three Tata developments are as follows :—

	Tata Hydro-Electric Power Supply Co., Ltd.	*Andhra Valley Supply Co., Ltd.*	*Tata Power Co., Ltd.*
Area of lake surface, sq miles ...	8.95	12.52	16
Catchment area, sq. miles	21.0		112.0
Effective storage, Millions of cu. ft. ...	9.03	12.85	16.25
Approx. Head, feet ...	1,725	1,675	1,640
Power House	Khopoli.	Bhivpuri	Bhira.
Total generating capacity installed ...	60,000 KVA say 48,000 K.W.	60,000 KVA say 48,000 K.W.	107,500 KVA say 87,500 K.W.
Length of transmission lines, miles ...	43.3	56.09	76.44
Receiving Stations ...	Parel	Dharavi	Dharavi.
Receiving Transformer capacity	70,800 KVA	63,000 KVA	108,000 KVA
Annual output, 1927-1928, millions of units	102	103	75
Approximate total capitalisation of undertaking. Rs. lakhs	280	510	720

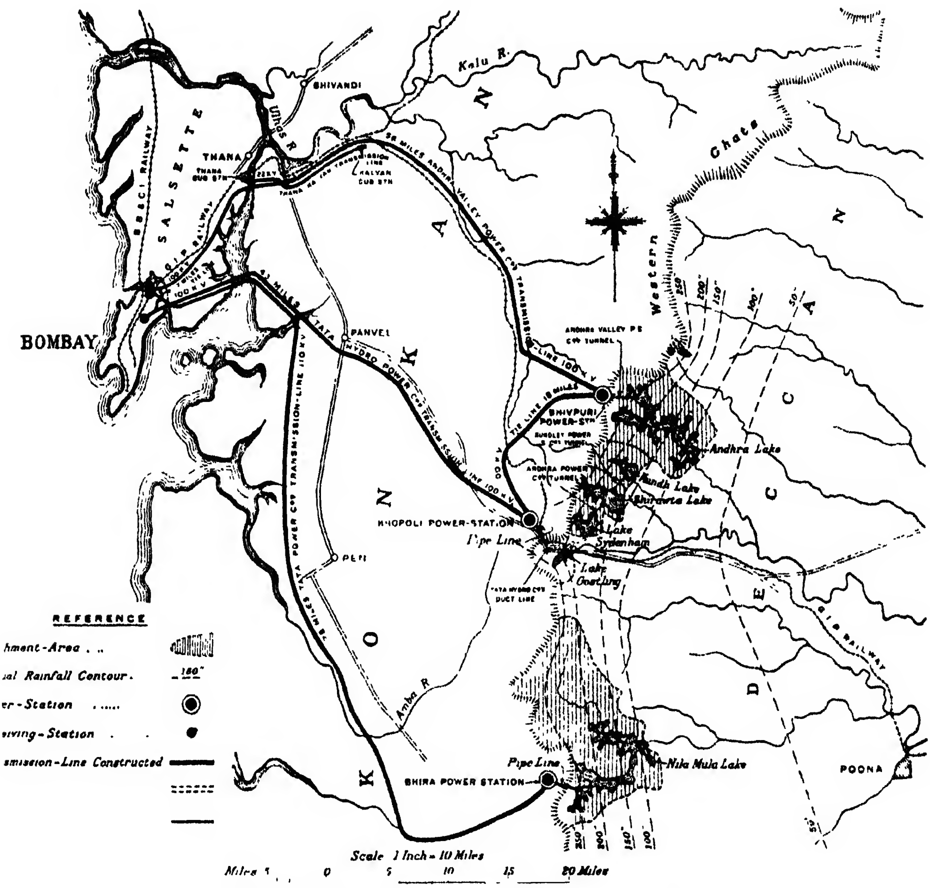
Approximate combined capitalisation per K.W. of generating plant installed—Rs 825

Dealing with the latest development, the Tata Power Company's scheme was commenced in 1919, and came into operation the year before last.

A 150 foot dam 5000 feet long closes the outlet from a catchment valley which originally provided the sources of two rivers, and which formed a junction at the dam site. A 4000 foot approach cut and 15,000 feet of tunnel lead the water to the pipe-lines descending to a power house containing five 17,500 k.w. 11,000 volt generating units driven by double overhung Pelton wheels operating on a static head of 1,640 feet. Four 30,000 k.v.a. transformer banks step the voltage up to 110,000 for transmission over a double tower line to a receiving station at Dharavi in Bombay, where it is stepped down to 22,000 volts for underground cable distribution in conjunction with the Andhra Valley Company's supply.

The Punjab Hydro-Electric Scheme. This is usually referred to as the Mandi or Uhl River project. It was located in 1922, and after exhaustive survey, received the sanction of Government in 1925, and in the following year a new hydro-electric branch of the P.W.D. was formed under the leadership of Colonel B. C. Battye, D.S.O., to carry it out.

Staff was recruited from all parts of the world, and the development of the Power Station site has now been under construction for nearly three years,



Map of Tata Hydro-electric undertakings.

during which period 100 miles of special railway has been constructed up to the site through the beautiful Kandra valley.

It is proposed, by agreement with the Rajah of Mandi, to make use of the snow-fed waters of the river Uhl, a tributary of the Beas which it joins in the Mandi State in the hills above Simla. $2\frac{1}{2}$ miles of tunnel will lead to a pipe line falling 1800 feet to the first power station designed for 36,000 k.w. with provision for increase up to 70,000 k.w.

As soon as this load has been placed the tail race can be taken through 3 miles of duct to a second fall of 1,200 feet to a second power house for another 48,000 k.w. There is also a third fall of 750 feet which could be developed if required.

Supply over a wide area is contemplated as the following list of towns denotes :

Towns to be supplied in the First Stage. Gurdaspur ; Dhariwal ; Batala ; Amritsar ; Lahore ; Sheikhupura ; Chuharkana ; Sangla Hill ; Chak Jhumra

Lyallpur ; Kasur ; Ferozepore ; Beas ; Jullundur ; Ludhiana ; Baghbanpura ; Shahdara ; Chheharta ; Tarn Taran ; Jandiala ; and in Indian States : Mandi ; Kapurthala ; Phagwara.

Towns that can be supplied eventually. Kalka ; Simla ; Kasauli ; Sanawar ; Dharampore ; Dagshai ; Solon ; Ambala ; Patiala ; Sangrur ; Phillaur ; Sialkot ; Gujranwala ; Raewind ; Changa Manga ; Okara ; Montgomery ; Pakpattan ; Faridkot ; Kot Kapura ; Muktsar ; Fazilka ; Abohar ; Delhi ; Shahdara ; Ghaziabad ; Meerut ; Muzaffarnagar ; Roorkee ; Saharanpur ; Karnal ; Panipat ; Sonepat ; Rohtak ; Dadri ; Jind ; Bhiwani ; Hansi, and Jaranwala.

For the present, transmission will be limited to the towns in the first list with 176 miles of 132 k.v. primary transmission to Lahore and about 200 miles of 66 k.v. branch lines.

Work has been carried out at four different levels, 4,000, 6,000 and 8,000 feet above sea level on one side of a mountain, and again at 6,000 feet on the other. About six miles of local railways have been constructed at these different levels connected up by electrically operated haulage ways. A very complete and up-to-date tunnelling plant has been installed and is electrically operated throughout from two small hydro-electric developments which have been constructed one on either side of the mountain through which the hydraulic pressure tunnel is being driven. Up to the present about three-quarters of a mile of tunnel have been driven and most of the excavation work for the power station and pipe line completed.

The construction of hydraulic works in the Uhl River valley itself has only recently been started owing to the difficulties of transportation which could not be overcome until the completion of the local haulage and railway system.

Contracts for the supply and erection of pipe lines, generating plant and transmission lines to the value of upwards of one million sterling are being negotiated in London. The work has been somewhat delayed owing to the difficult nature of the country, but it is hoped that supply may be commenced about the end of 1931 or the early part of 1932.

The total initial capital outlay is put at Rs.461 lakhs (Rs.1280 per k.w. installed), and it is proposed to sell at an average all-round rate of Rs.157 per k.w. year, which at an ordinary mill load factor would be equivalent to about .75 anna per unit. If the full scheme is developed, materially lower rates are contemplated.

In addition to general electric supply to the towns scheduled, the Punjab Government anticipates that the Uhl River scheme will assist agricultural development in the province by the aid of tube-well irrigation of uncommanded land on the one hand and of drainage of water-logged areas on the other.

Madras Presidency. Estimates have recently been put forward in connection with a 40,000 Horse Power development in the Nilgiris called the Pykara-Moyar

project involving the construction of two power stations in series hydraulically and with heads of 3,250 and 1,000 feet respectively.

Three different methods of developing the catchment area have been submitted within the past year by Major H. G. Howard, M.C., Chief Engineer, Hydro-Electrical development, Madras Presidency, and have been sent on for scrutiny by the Government of India, the most promising of the three schemes having been previously examined and approved by a prominent firm of Consulting Engineers.

Although at one time a 360 mile transmission to Madras City was tentatively proposed, it is not expected that this will be considered at the outset, and it appears to be extremely unlikely that such a proposal will ever be revived.

Apart from these projects little further appears likely to be done with India's millions of water horse-power.

Hydro-electric propositions may be divided into two broad categories :—

Those involving *transmission* in bulk to one or two districts offering large demands, of which the Tata scheme is an instance, and those involving *distribution* over wide areas to scattered demands of small individual magnitude as is proposed in the Punjab.

In the first case the capital outlay per kilowatt capacity rendered available may be from three to five times that of a local thermal power station, and as improvements recently made and foreshadowed in steam boiler and turbine efficiencies and in the scientific treatment of coal bring the fuel portion of the cost of supply down to low levels, the disparity in capital charges will generally place the thermal station in a favourable position. Moreover, as the total cost of the supply of electrical energy, including capital charges, varies inversely as the output sold per unit of capital expended, it follows that hydro undertakings are far more sensitive financially to any declension from the ideal conditions of operation, viz: those of continuous output at the maximum capacity for which they have been equipped.

Turning to the second category, that of long distance *distribution*, the heavy cost of tapping high voltage lines creates a serious financial handicap. For lines of 100,000 volts and upwards, the cost in the present state of the art is more or less fixed irrespective of the demand to be fed, and if all proper safeguards are taken, is probably in the neighbourhood of Rs.2 to Rs.3 lakhs per tapping, a very heavy initial outlay in respect of supply to a small town or community.

Furthermore, reliability and stability factors enter prominently into the question of long distance transmission and distribution, while the difficulty of effecting adequate inspection patrol is emphasised under Indian conditions.

Except in specially favourable cases, therefore, it is to be feared that the results of the work of the surveyors of the water power resources of India are likely long to remain of academic interest only.

Industrial Electrical Developments.

The great sub-continent of India, which is larger than Europe without Russia, has diametrically opposite labour characteristics from those with which we are accustomed at home, inasmuch as the lure of the country rather than that of the city is predominant among its population.

Accommodating a fifth of the human race with three-quarters of its inhabitants devoted to the cultivation of the soil, less than 10 per cent. of whom are literate, with its hundred languages and thousand dialects, India has been described by a great journalist as an ocean of all-pervading agriculture studded with a few widely scattered industrial islands.

This description may be emphasised by recording that India has only 33 cities with a population of over 100,000, few of which may be characterised as industrial in the Western sense, but that it possesses 700,000 villages, in which cottage industries are carried on during the periods of enforced agricultural idleness imposed by seasonal conditions.

Parallel with these handicrafts, however, there has been a steady growth in mechanical industrialism in which electricity plays such a dominant part, but, as already stated, it is so far limited to a few manufacturing centres.

One of our leading contractors with wide interests once told the writer that he always employed the same unit figures for labour plus supervision, which he claimed cost the same the world over, but owing to the intermittent indulgences in manual labour, other than agriculture, which the Indian has until recently allowed himself, to his consequent detriment from the industrial employers' point of view, these standard costs would probably be found to be on the low side if applied to Indian conditions. For this reason and owing to the difficulty of obtaining even indifferent labour adequate to the needs of India's industrial islands, the use of electrical energy has become almost a vital necessity for their economic welfare and existence.

Outside the chief centres of population, which have already been dealt with, there are a few instances in which local conditions with regard to raw material have led to the establishment of isolated cases of mechanised industry, the outstanding example of which is :—

The Tata Iron and Steel Company. Situated at Jamshedpur about 150 miles to the west of Calcutta, and built upon a site on which 20 years ago stood the village of Sakchi in the primeval jungle, the works of this important company are electrically self-contained and own two steam power stations, having capacities of 11,750 and 25,000 k.w. respectively. An 18,000 k.w. set is shortly to be installed in the larger station, and the smaller will then be shut down, leaving a single station of 38,000 k.w. capacity.

Power is transmitted overhead at 3,000 volts 3-phase, 50 cycles, and is used for many purposes in the manufacture and refining of steel. The annual demand is 150 million units a year, about the same as that of the whole of the City of Calcutta. Over 100,000 h.p. of motors are installed, the largest

being 6,500 h.p. About one-third of this horse power consists of direct current motors, for speed control reasons, the conversion from alternating current being carried out by fly-wheel motor-generators in the case of supply to the large reversing mills, and by ordinary motor generators for the smaller motor circuits, the latter being arranged to operate as 80 per cent. leading power factor in order to correct the alternating current system. The latest addition to the Steel Company's electrical plant is that required for a new reversing roughing mill and consists of a 4,000 h.p. direct current slow speed reversing motor with a 3,800 K.W. flywheel motor-generator set, the latter being fitted with a 33-ton flywheel constructed from three steel plates, 13ft. 6in. diameter, and each over four inches thick.

Bundi Portland Cement Co., Ltd. The works of this Company, situated at Lakheri, are completely electrified, and important additions have recently been made. About 7,000 K.W. of 500-volt 3-phase generating plant is installed and distribution is carried out underground, outlying departments being fed at 3,300 and 6,600 volts via step-up and step-down transformer banks, some of the larger motors, however, being operated direct at 3,300 volts.

Nearly 100 motors of various sizes are used (the smaller, in view of the working conditions, being totally enclosed), while electrical energy is used for testing apparatus, welding, and for laboratory furnaces.

Colliery Electrification. The application of Electricity to Coal Mining in India is slowly gaining ground, as is shown in the following official statistics of Electric Motors installed.—

	1924.	1925.	1926.	1927.
H.P. on surface ...	13,564	15,501	16,192	16,440
H.P. below ground ...	29,938	36,835	38,356	43,099
Total H.P. ...	43,502	52,336	54,548	59,539

The use of electrically driven coal cutters has not been developed to any great extent, the number in use having only increased from 109 in 1924 to 124 in 1927, about equal numbers of the American chain and the British bar type being employed.

Although many Indian coal mines have their own power plants, Colliery Supply undertakings have been formed in certain areas, recent examples being as follows :—

Name of Undertaking.	*Dishergarh Power Supply Co.*	*Associated Power Co.*	*Sijua (Jherriah) Electric Supply Co*	*East Indian Railway Co.*
Coalfield	Raniganj.	Raniganj.	Jharia	Giridih.
Number of Collieries supplied	19			Several
Total plant capacity K.W.	8,000	1,750	8,000	2,450
Transmission voltage ...	11,000	3,300	6,600	2,200
Total connected load : H.P.	9,867	4,550	10,034	3,414

Electric Traction.

Electric Tramways have been in operation in the principal cities of India for many years, but the application of electric traction to railways has been somewhat backward, for although the electrification of the suburban sections of the two railways running out of Bombay City was investigated as far back as 1912, it was not until 1922 that sanction was given to the first electrification scheme, that of the suburban section of the G.I.P. Railway over which the first electric trains were run in February 1925. In September of that year the Indian Railway Board sanctioned the electrification of the main line routes on that Railway out as far as Igatpuri and Poona, thus making, with the suburban section, a total of about 300 miles of electrified track.

In 1923 sanction was given in connection with the suburban section of the B.B. and C.I. Railway out as far as Borivli, but owing mainly to the coal strike in this country it was not until January of last year that the electrified service came into operation.

In the early days of railway electrification several different systems of electrical transmission, collection, and utilisation were installed in Europe and the Americas, and for many years what was then referred to as the "battle of the systems" was fiercely fought. In one case just prior to the war, five different propositions were put forward by manufacturers in connection with the electrification of an important mineral line.

Realising the necessity for a measure of standardisation the British Government in 1920 appointed an Advisory Committee upon the Electrification of Railways, and their report published in 1921 as revised last year lays down as standards generation and transmission on the 3-phase 50 cycle alternating current system, and transformation to 1,500 volts direct current for use on the tracks, with collection from an overhead conductor.

As this standard system was decided upon as far back as 1912 by the two railway companies operating the suburban lines running out of Bombay city, (overhead conductors being then chosen mainly on account of track flooding difficulties and incidentally of the tendency of Indians to trespass on the lines) its choice gives evidence of the foresight of their consulting engineers, Messrs. Merz and Partners.

Descriptions of the Bombay electrification scheme have been so widely published that only broad details need be recorded. 3-phase electrical energy is taken from the Tata group of Hydro-Electric Companies, and is generated in the Ghats 60/70 miles inland and transmitted overhead at 90/100,000 volts to receiving stations in the neighbourhood of Bombay City, where it is stepped down to 22,000 volts for retransmission partly overhead and partly underground to rotary substations at strategic points alongside the railway tracks. At these substations it is converted to 1,500 volts direct current for use on the overhead conductor system, the ordinary rails suitably bonded acting as the return circuit.

In the case of the B.B. and C.I. suburban section, the sub-stations, three in number and having a total capacity of 20,000 k.w. are of the supervisory controlled type, manual operation being entirely dispensed with, and all high and low pressure switching being dealt with from a single central control office.

The control is effected with the aid of apparatus similar to that used in automatic telephone exchanges, selectors being employed to transmit low voltage impulses over 3 core pilot cables to similar selectors in the substations. These selectors bring relays into action, which prepare the switchgear for the selected operation and then transmit a signal back notifying that the selection has been made. A push button at the control office then enables the operation to be carried out, after which a second and confirmatory signal is transmitted, indicating that it has been completed. The whole sequence takes about 3 seconds.

In the case of the G.I.P. suburban sections the substations are arranged for manual operation, with, however, automatic features in certain cases.

The overhead equipment consists of a trolley wire with catenary suspension carried on lattice steel structures having a normal spacing of 220 feet, the total copper section being .625 sq. inch on each track.

For suburban service on both railways all-steel rolling stock units, consisting of one motor and three trailer coaches, are used, and preparation was made for the new stock to have an overall width of 12 feet as compared with the then existing standard maxima of 10ft 6ins. for four-wheeled stock and 10ft. 0ins. for bogie stock The overall length of the coaches is 68 feet, and when equipped for third class they accommodate 120 passengers each, i.e., nearly 1,000 passengers in a two-unit train consisting of eight coaches.

The normal maximum running speed of the suburban trains is 48 m.p.h.

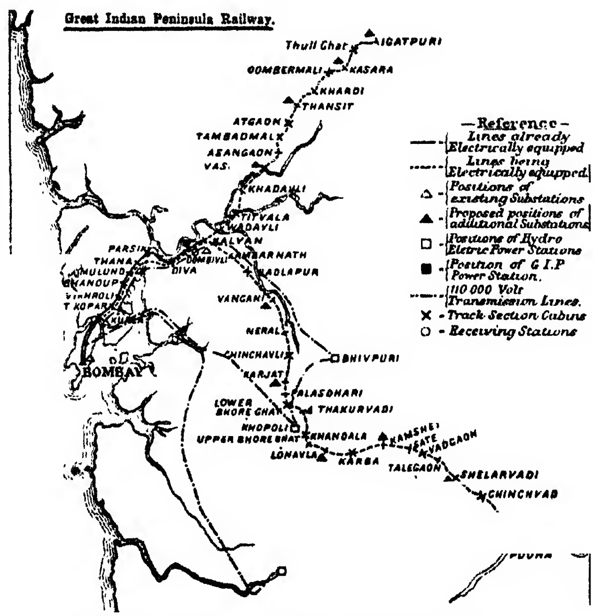
As regards the effect of this electrification, to quote the Report of the Railway Board : " These services have become highly popular and promise to be entirely successful."

With regard to the main line electrification of the G.I.P. Railway from Bombay to Igatpuri and Poona via the Ghats where the maximum ruling grade is 1 in 37, special high speed locomotives will be used for drawing the ordinary rolling stock.

Over a few miles the railway mounts more than 2,000 feet, and the tractive conditions are, therefore, specially arduous, and when coupled with the exacting climatic conditions of high temperature, torrential rainfall and liability to track flooding, the greatest care upon the part of the Consulting Engineers and the manufacturers has been called for in deciding upon a suitable design.

After consideration of different British and Continental designs, three sample locomotives were ordered from different manufacturers, and after trials and tests, twenty-one passenger and forty-one freight locomotives were ordered from the Metropolitan-Vickers Company. Brief details of these two types are as follows :—

	Passenger.	Freight.
Overall length ...	66 feet	66 feet
Total weight	100 tons	120 tons
Adhesive weight ...	60 tons	120 tons
Maximum Service Speed	75 m.p.h.	45 m.p.h.
Motors	6 of 360 h.p.	4 of 650 h.p.



Map shewing electrification of G.I.P. Railway.

It is intended that some of the freight locomotives shall act as banking engines to assist the passenger type when negotiating the heavy grade sections on the Ghats, and the characteristics of the two types are such that they will operate and share the load satisfactorily together. All are arranged for regenerative electric-breaking, i.e. when descending the steep gradient they will return energy to the system, and it is anticipated that their operation, coupled with the elimination of the present reversing stations rendered possible with electric traction, will reduce the running time between Bombay and Poona (119 miles) from over 4 hours to under 3 hours.

The overhead equipment on the mountain sections of the mail line possesses novel features as, in view of the heavy currents to be dealt with, a total section of 1 square inch of copper is carried above each track divided between a main

catenary (.5 square inch), an auxiliary catenary (.2 square inch) and the trolley wire (.3 square inch). The main catenary is supported at 220ft intervals as in the case of the suburban sections.

The whole of the power for the operation of the two Ghats sections of the G.I.P. Railway will be drawn from a thermal power station now under construction at Kalyan. This will be equipped with four 10,000 Kilowatt generating units and six stoker-fired boilers arranged for 270 lbs. steam pressure, 725° Fahrenheit total steam temperature and fitted with oil firing equipment for overload forcing purposes.

Generation will be at 6,600 volts 3-phase 50 cycles stepping up to 95,000 volts for transmission to eleven rotary substations, some arranged for manual, others for supervisory remote control.

Work on this important main line electrification is well advanced, and it is hoped that electrical operation will come into force on the Poona section during the coming summer, and on the Igatpuri section during next year.

With regard to other Indian Railways, the electrification of the suburban section of the South Indian between Madras Beach and Tambaram has been sanctioned, and propositions in respect of certain main line sections of that Railway have been put forward, but so far no decision has been arrived at.

With regard to the Calcutta suburban lines, electrification has been considered, but in view of the heavy expenditure involved the matter has been referred back for further investigation.

Special Application of Electricity to Steam Railway Requirements.

For many years progressive use of electricity has been made by the Railways of India for train lighting, workshop driving, welding, pumping, crane and capstan operation and so forth, and perhaps the only recent application which, in view of its interesting nature, calls for record, is the general application of electric headlights to steam locomotives.

About 85 per cent. of the steam locomotives have so far been fitted, and the Railway Board are considering the advisability of making such headlights compulsory.

The generator for the supply of the electrical energy must, of necessity, be located on the locomotive itself, and it takes the form of a 32 volt 500 watt steam turbine-driven set which is bracketed off the side of the boiler casing. There are several types with both alternating and direct current generators, but the British product introduced a couple of years ago is a turbo-alternator of outstanding simplicity.

A single wheel steam turbine drives an inductor type of alternator, having a toothed rotor without windings of any sort and a stator consisting of permanent magnets with laminated pole-tips carrying only two small fixed coils embedded therein. There is consequently no commutator or collector. The permanent

magnets require remagnetising at infrequent intervals but electro-magnets are provided for this purpose as part of the standard equipment.

Only 250 watts, i.e. half the output of the turbo-alternator, is taken by the actual headlight, the other half being applied for lighting the cab, gauges, lubricators and tender, while a portable lamp can be plugged in for inspection purposes.

Broadcasting.

Concluding with this latest example of electrical application, wireless broadcasting on the lines of the B.B.C. came into operation in 1927 through the medium of stations in Calcutta 7CA (370.4 metres) and Bombay VUB (357.1 metres) operated by the Indian Broadcasting Company, a subsidiary of the Indian Radio Telegraph Company. These stations although of the same transmitting power as 2LO, viz: 3 kilowatts, have been found under Indian climatic conditions to possess much greater transmitting ranges, and regular reception is reported from the North-West provinces, from Ceylon, and even from the Malay States 1,800 miles away. Fading, which is not usual with 2LO, is, however, very pronounced at times.

So far broadcasting has not captured the imagination of the Indian public to a degree sufficient to make it a financial success, but the Company are of the opinion that if they are patient and keep a good service going they will eventually obtain the necessary number of license holders, which is at present less than 10,000. Should financial success be ultimately achieved, additional transmitting stations will no doubt be installed at such centres as Delhi and Madras.

I wish to record my grateful appreciation for the full information so readily given me by many friends, firms and officials, both in India and this country and from which I have been forced to make a very condensed selection.

My thanks are also due to the following firms for the loan of photographs and lantern slides: British Thomson-Houston Co., Ltd.; British Insulated Cables Co.; Callender's Cable & Construction Co.; Cammell, Laird & Co.; English Electric Co.; General Electric Co.; Metropolitan Vickers; J. Stone & Co., Ltd., and "The Times of India."

DISCUSSION.

Mr. J. W. Meares, C.I.E., M.Inst.C.E., M.I.E.E., as one of the pioneers in India of the electrical industry, was very glad to have been present at the reading of this very opportune paper. He said that because, after what Mr. Cooper had told them, they would be a little amused to hear what was said recently in an important publication by the World Power Conference. That important international body issued a report on the power resources of the world, and after enumerating the countries where a first approximation had been made towards the assessment of water power resources, it stated that the rest of the world

remained to be examined right from the beginning. The rest of the world included India. Mr. Cooper had told them about the three actually working Tata schemes—schemes of enormous importance and the only ones of their sort in the world dealing with stored water pure and simple with no river flowing through them—and other schemes which were coming on, which might or might not be successful, hereafter. Speaking of world power production, the same document said later on: "In Asia, India, China and Siberia remain to be exploited." China and Siberia, it would be noted, were coupled with the Indian Empire, which had been in many ways a pioneer, and had certainly put forward extraordinarily good work.

One could not but notice, to Mr. Cooper's entire credit, that, unlike most officials, he had evidently not had much to do with hill stations in India. Some of them, on the other hand, had spent as officials an undue proportion of their time there. In the table dealing with automatic telephony Simla, which, he thought he was right in saying, had the first automatic telephone system in India, was not mentioned, while Darjeeling had the first hydro-electric scheme. It was put in by himself, so he knew that it was the first. It was a small scheme. It had been followed by quite a number of other schemes in the hill stations scattered over India, and those schemes, though small in their way, were of considerable importance and highly successful. There was no question that sooner or later the hill railways would have to be electrified. There was water power on the spot in almost every case.

As a matter of history, when he went to India in 1896 the only public lighting installation, so far as he knew, was in the Eden Gardens, Calcutta, and it consisted of Jablockhoff candles. That system came into use in the seventies, and disappeared from the face of the world elsewhere in the eighties, but was still working in Calcutta in 1896. When he suggested that modern lighting should replace those candles the Bengal Government said, "What is the matter with them? They have been working for thirty years, and will go on working for a long time. Why replace them?" It was found afterwards that those candles cost three times as much per annum as the whole power upkeep of the modern lamps which replaced them. That was a rather good lesson to Governments bent on economy in capital expenditure and squandering money regardlessly on maintenance.

Another small point he noticed was that the Cauvery scheme, which was the first hydro-electric scheme in a native State in India, was not among those mentioned in the paper, though it was a scheme of great importance to the goldfields in the State, and had done extraordinarily well. At the other end of the scale the Kashmir scheme, which had done very badly, was also not included.

The lecturer did not seem to think that the work of the hydro-electric survey would come to much. In inaugurating that survey, Sir Thomas Holland looked a long way ahead. The work done remained on record, the sites were known, and to a certain extent investigated, and he thought there would be openings for them. He would like in particular to mention the wonderful work that Sir Gunga Ram did in the Punjab with his little hydro-electric scheme for irrigation by pumping. That was an application of electricity which made use of water power from the local canals, and had immense possibilities in the irrigation of the "uncommanded" areas above the canals. Sir Gunga Ram had shown the way, and that there was a future for such a development he (the speaker) felt certain. The only possible thing against it was that the same thing could be done by the "hydrautomat," a purely mechanical apparatus, which was being installed in quite a number of places in the Punjab.

Turning again to water power, he agreed with Mr. Cooper regarding the distinction between the hydro-electric station supplying bulk power in an industrial area and the stations with a supply spread over a very large area. He must confess to the gravest doubts whether it would ever be possible to make a profit on the Punjab scheme because of the enormous number of small places which would have to be tapped by lines of moderate pressure. The capital cost would, he thought, be prohibitive. There was still a use, however, for the larger station transmitting to industrial areas. Such areas might not exist at the moment, but where power was available industry often followed.

Mr. G. B. Gill (Messrs. Merz and Partners) said that Mr Cooper had mentioned that some direct current extensions with rotary converters were being installed in Bombay and Calcutta. He would like to ask whether that development had Mr Cooper's approval, seeing that it was more usual nowadays to extend with alternating current. Had the Indian Government any powers with regard to electricity supply? From the particulars given in the paper, it appeared that development was taking place on English standard lines. This was important, as English manufacturers could take a large share in the four million pounds which Mr. Cooper stated to be spent annually by India on imports of electrical apparatus, machinery and accessories. Incidentally, if English standards were employed, care must be taken in the selection of distribution voltage, remembering that Indians often worked barefoot.

With regard to the details of the electrification work in Bombay, perhaps Mr. Cooper would permit him to amplify some of the information given in the paper. When the electrified service first started, a considerable amount of trouble was caused by that well-known bird, the Bombay crow. This crow liked, if possible, to build his nest of wire and often selected the overhead equipment structures as nesting-places When carrying wires about, they were often dropped on the overhead equipment. The results were somewhat spectacular and the railway service was considerably interfered with, the overhead equipment wires in some cases being burned through. Eventually a somewhat expensive system of guards had been devised, though this was not completely effective, and he thought that a certain amount of trouble from the crow would always have to be legislated for. Thieves also caused trouble. In one case the copper bonding of the rails disappeared the day after it was put down, and in another case when a small section of transmission line which had been out of use for some time came to be switched on it was found that the wires were missing.

A picture of a train running through floods had appeared on the screen. It might be interesting to know that those floods were sometimes three feet deep; but even at that depth the motors had hitherto functioned very successfully. In one train unit of four coaches the motor and coaches were so arranged that two coaches were pushed in one direction and hauled in the other. There had been no trouble at all with that method of traction. On the suburban section in Bombay the traction system was just about complete, and running would start very shortly. The goods yards were now being worked electrically.

On the main line extension up to Igatpuri and Poona there would be eleven sub-stations, each with two or three sets of 2,500 kilowatts. Five of the eleven would be attended and six unattended; an unattended sub-station would be controlled from an adjacent attended sub-station. That helped to cut down the running expenses considerably. The duplicate 100,000-volt transmission lines which followed the railway route had no special features, but on the Ghats section

towards Poona, where there was a rise of practically 2,000 feet, maintenance conditions during the monsoon were very difficult, with seven or eight inches of rain a day. On this section, therefore, which was more liable to trouble than any other, a third transmission line had been put up which could be switched in if conditions warranted it.

The Calcutta electrification scheme was given comparatively few lines in the paper, but he thought that more would be heard of it fairly soon. There were difficulties there which were partly financial and partly engineering. For a sound engineering scheme, however, it was necessary that the two main terminal stations in Calcutta should have a direct rail connection This necessitated either a railway bridge over the river or a tube railway. The problems involved were under close consideration.

It was his experience that there was a considerable shortage of Indian artisans for electrical work, though there were a certain number of good men available. The present arrangements for educating these men seemed to be a little wanting. The Indian training colleges were doing good work, but he thought that Indians were not being turned out in the way they ought to be for the erection and maintenance work of electrical equipment. Far too often English manufacturers had to send out their own workmen to do work which should be done by Indians. The Indians who came to this country for training were not of the class that worked with their hands when they returned to their own country. The general question of training workmen was a point which the Government ought to look into in order that men could be trained so as to keep pace with electrical progress in India.

THE CHAIRMAN thought that the reason why the schemes referred to by Mr. Meares were not mentioned in the paper was contained in the first word of the title, "Recent," which Mr. Meares seemed to have overlooked. As to the automatic telephone at Simla, of which he had had experience, possibly the lecturer had not mentioned it because the Royal Society of Arts was rather particular about the language used in their hall!

He claimed to speak with some authority on hydro-electric development, as he had had some experience, first of all as a Director of a great hydro-electric company; secondly, from association with a company that used hydro-electric power in bulk; and, thirdly, as one who tried to sell it To him Mr. Cooper's paper was of extraordinary interest, not only for what was actually said in it, but for the lines of thought it suggested.

The paper referred to the comparatively low consumption of electrical energy per head in India. That seemed to him to arise in the main because only one company in the whole of India, so far as he knew, had ever attempted to sell electricity, though a large number of companies supplied it; but supplying and selling were as wide as the Poles asunder, and experience showed that if the question of selling was systematically dealt with, the Indian market, certainly in the great centres of population, was likely to be just as receptive of electrical and mechanical energy as that of any country in the West. That was one more example of the unmitigated nonsense of contending that the Indian community did not respond readily to modern conveniences and facilities.

A very valuable portion of the paper was that in which the lecturer suggested, rather than said, that very careful consideration was necessary before gigantic sums were spent on hydro-electric schemes. After the war people had water on the brain. Speaking from some experience, although in theory water power ought to be and might be cheap, in some cases it was dearer by nearly one-third than

thermal power. Apart from that, painful experience had shown directors and shareholders how great was the capital charge of hydro-electric works before a single unit could be sold, to say nothing of working to capacity.

He believed that they were on the verge of a great development of thermal efficiency through high pressures and the pre-treatment of coal, and that necessitated intensive consideration before colossal sums were embarked in hydro-electric power schemes. He ventured to invite attention to this consideration specifically, because the lecturer had given figures showing the estimated selling rate of electrical energy from particular hydraulic works. If any of those present were engaged in such projects he would say to them, " If you think you are going to sell electrical energy in bulk or to retail it in large quantities for domestic purposes at a higher rate than .5 anna per unit, you are making a mistake which will have disastrous effects upon your own pockets and upon the fortunes of those who are foolish enough to trust you."

A careful study of the paper would show that Mr. Cooper had indicated lines of thought of profound significance to those engaged in electrical development in India, and he would like to express his personal gratitude to Mr. Cooper for the lucidity and care with which the facts were put forward.

He had a train to catch, and perhaps those present would excuse him. He would ask Sir Charles Armstrong to take the Chair.

(Sir Charles Armstrong accordingly took the Chair.)

Mr. H. R. Bhatia asked what was the lecturer's view regarding the transmission voltage adopted by the Punjab hydro-electric scheme. Compared with long-distance transmission lines elsewhere, it would seem that a higher transmission voltage would be justified. Would Mr. Cooper also give information as to how many units were proposed to be installed in that scheme ?

Regarding the third section of the Tata Power Company, he understood that the construction of that section was embarked upon in view of the demands of electrification schemes undertaken by the suburban railway companies of Bombay. The latter were now erecting their own power plants Did the lecturer think that the Tata Power Company would be able to secure more demand for this power house ?

Mr. J. G. Griffin agreed generally with what was said in the paper about the supply of hydro-electric power. A point that appealed to him very strongly was that with long transmission lines, some of them going over wide rivers and across comparatively inaccessible places, there was the possibility of a failure of supply owing to political troubles, or even individual miscreants.

In regard to thermal stations, Mr. Cooper had not referred at all to Diesel engines ; there were several successful Diesel power stations in India. There was a very large field in India for the supply of cheap electricity. Small electrical stations could be put down comparatively cheaply, and if the organisation was properly arranged and the right methods adopted, he believed that an electricity supply could be profitably installed and run in a considerable number of the smaller towns.

Mr. A. T. Cooper, in reply, explained that his paper was more or less an historical survey of Indian electrical progress during the last five or six years, and naturally did not call for very much in the way of discussion in the ordinary sense of the term. He was, however, very gratified at the interesting comments it had evoked.

In reply to Mr. Bhatia's question about the voltage of 132,000 selected by the promoters of the Punjab scheme, he was afraid he did not know why that particular voltage was pitched upon; but it happened to coincide with that used in connection with the British "Grid," for which equipment was being more or less standardised. Considering the transmission distances ultimately involved (Delhi being something like 400 miles away), the voltage did appear low, although the old rough rule of "1,000 volts per mile, plus 1,000 volts for luck," had long since gone by the board.

With regard to Mr. Bhatia's pertinent query as to whether the Tata Power Company would be able to secure sufficient demand to load up their new power house, this appeared to be entirely in their own hands and depended upon the rate at which they were prepared to sell, and as to how far they could meet the decreasing costs of thermal generation.

Mr. Meares rather reproached him for not mentioning some of the earlier electrical schemes in India. The paper dealt only with progress during the last five or six years, and he pointed out that Mr. Meares himself had already discussed those early schemes in a paper read in 1922.

Mr. Gill had very kindly amplified the details of the G.I.P. electrification and had asked a question regarding the extension of direct current areas by some of the Supply Authorities in India. Most of those Authorities, including the three Presidency Cities of Madras, Calcutta and Bombay, started in the early days of electricity supply, when everything was on direct current lines. As time went on, the advantages and flexibility of alternating current generation and distribution came to be recognised, and in all those three cities, he thought—he he knew it was so in the case of Bombay because he carried it out himself—a cordon was put round the original direct current area, and it was said, "Thus far and no further." All the outskirts were dealt with on alternating current lines. The advisability of changing over those direct current areas to alternating current in order to make the supply homogeneous had been considered; but with Indian distribution it was a much more expensive matter than in this country because of the enormous number of fans.

Mr. Gill had also raised a point with regard to Government control of electricity supply. The Indian Electricity Law was modelled on British lines with, however, thanks to Mr. Meares, considerable improvements in several respects, and as most electrical developments in India were carried our under home guidance, British standards of voltage and frequency were being generally followed. As regards the risk of shock he did not think that an Indian with thick-skinned bare feet was in any more danger than a tender-footed European in wet shoes!

Mr. Griffin had complained of the absence of reference to Diesel engines, but he had recorded the use in most of the smaller cities of oil-engine driven installations.

From his knowledge of costs of production with the latest types of oil-engines he agreed with Mr. Griffin that their use for small electric supply installations was fully justified. Where the dividing line lay between oil-engines and steam turbines it was difficult to say, as it depended so much upon local conditions both initial and potential, but he felt confident that in most cases the two thermal methods of generation could hold their own against all but the most favoured hydro-electric propositions.

As Thomas Edison recently said: "A great deal more fuss is being made over hydro-electric power than its intrinsic value warrants."

He was very grateful for the kind words used by Sir Stanley Reed in his comments on the paper, the preparation of which had given him a great deal of pleasure.

THE CHAIRMAN (SIR CHARLES ARMSTRONG), in moving a very cordial vote of thanks to Mr. Cooper for his comprehensive and interesting paper, said that Mr. Cooper and he were both Bombay men, and had been interested a good many years in the same electrical concern—the Bombay Tramways Company. Twenty-five years ago the then Managing Director had shown him round a new power station which had just been erected and was the very latest thing in electrical development. Ten or twelve years later, as he gathered from Mr. Cooper, that power station was more or less closed down, and the power was taken thereafter from the Tata Hydro-electric Company.

His own interest in electrical development in India had been rather more recent than that, because he happened to be Chairman of the Great Indian Peninsula Railway when the work of electrification was going on. Before the work was completed, however, the Government of India took the railway over, and he had not seen the actual electrical working of the suburban traffic; but the work was being carried on during the few years that he was Chairman. It was a very big piece of work and a very necessary one, because it was the only way of dealing with the very dense population of Bombay and of enabling them to live outside the island. Electricity brought many improvements into India. It gave Bombay electric trams and electric fans. He could not say that he liked the latter, but some people liked them very much.

He was very much obliged, and he felt sure that everyone present was very much obliged, to Mr. Cooper for his most excellent paper.

The vote of thanks having been carried unanimously, the meeting terminated.

COLONEL AUBREY O'BRIEN, C.I.E., C.B.E., writes:

Mr. Cooper, in his interesting paper, sounds the necessary note of alarm with reference to the Punjab Hydro-Electric scheme, of which the first stage is now well advanced. The capital expenditure will be very great, over 4½ crores for the production of the first 36,000 kws., and it is essential that the supply available should be quickly taken up. The cost of tapping the main transmission line also necessitates that any town which takes power should be quickly assured of a brisk consumption. To counter this, the Hydro-Electric branch in estimating probable consumption has only taken into consideration the industrial demand, whereas, if power is really to be of use to an agricultural province like the Punjab, it must be used, wherever possible, as an assistance to agriculture. The Punjab peoples are enterprising and quick to take up mechanical devices, but they will require continuous propaganda and education in a science entirely new to India. They will have to be taught all that is known in the countries which already harness electricity to the needs of agriculture, so that the period of discovery of those uses which are suitable to the Punjab may be cut down as much as possible. Fortunately, cultivated fields and gardens touch and even intermingle with the houses of the biggest cities, and, though holdings are small, the Co-operative Societies are more advanced in the Punjab than in any other province of India.

The greatest assistance that can be given to agriculture in the Punjab is the provision of water, and here it has been calculated that electro-pumping could add 6,000 cusecs. to the visible flow supply, the equivalent of adding another river to the province. Two and a half million acres of land now dependent on rain might be annually irrigated, while land, now waterlogged, or threatened with waterlogging, could be saved and the water sent on to thirsty country elsewhere. There are difficulties in this connection, difficulties with regard to the right type

of tube wells, but especially with regard to the charges for the water supplied. Canal water has been steadily cheapened in recent years, and, although the profit from the land would amply cover the cost of pumped water, people will have to be educated up to paying for it, especially those who, for the cure of waterlogging, must rightly have their canal water taken from them.

If long distance distribution is to pay anywhere, the Punjab is best situated for the experiment. Bengal coal is about one thousand miles away, and though there is a small supply of oil at Khaur, near Rawalpindi, the price has been assimilated to world prices, raised high for India. Mr. Cooper's note with regard to reliability and adequate inspection patrol is of importance, for an interruption would be disastrous during the furnace heat of the Punjab summer, but the main line and principal branches would be easily supervised, and the communications of the province are on the whole good.

OBITUARY.

Mr. L. B. Keyser.—We regret to announce the death of Mr. Leonard Bethell Keyser, which took place recently at his Winchester home, in his 73rd year. He was the youngest son of Mr. Alfred Keyser, of Cross Oak, Berkhamstead, and was educated at Clifton. He was closely associated with Winchester for the last 28 years of his life, becoming Secretary of the Hampshire Club in 1901 and a leader in many local public activities. In 1913 he was appointed honorary treasurer of the Royal Hampshire County Hospital, and his many valuable services to the hospital included the establishment of a contributory scheme, under which voluntary contributions gave contributors a right to hospital treatment. This reform - introduced here for the first time in connection with a provincial hospital has been strikingly successful, and contributors to the scheme now number over 30,000, and the finances of the hospital have been much benefited. In his youth Leonard Keyser was a fine Association football player, and in later life he became a keen golfer; he was also one of the oldest members of the M.C.C. He had been a member of the Royal Society of Arts for nearly 50 years, having been elected in 1880.

NOTES ON BOOKS

Early Church Art in Northern Europe. With special reference to Timber Construction and Decoration. By J. Strzygowski. London: B. T. Batsford, Ltd. 21*s*.

One of the most exciting "ifs" in history is this. What would have happened if King Harold, in the celebrated year 1066, had been beaten by Harald Hardrada, and if William of Normandy had then met not Harold but Harald, and had also been beaten by him? Those children and adults for whom history is only a subject taught at school may remain under the impression that Hardrada and his people were a sort of barbarians; they were, of course, nothing of the kind, but a civilised race with art as well as enterprise to their credit; and it is possible that they were the first, therefore the real, discoverers of America.

Professor Strzygowski complains, not that people are unwilling to discuss "what would have happened if—," but that they shut their eyes to events which did occur, and which have left traces that can be examined. Thus architecture, he alleges, is regarded as forming one main stream from classical times, no allowance being made for tributaries. In this book he shows that timber construction in Northern Europe has in the past been referable to intelligible and intelligent native principles unaffected by the classical tradition.

"During the dark ages," says Professor Strzygowski, "we are not at the beginning but at the end of a flourishing northern art," an art which penetrated as far south as the coast of Dalmatia and Spain. Before the Romanesque style gained its supremacy the native architects of Western Europe were building in wood framework, those of Eastern Europe in wood blockwork, those of Northern Europe in wood stavework, or "mastwork," as Professor Strzygowski calls it. Wood is, unfortunately, very perishable, and as the Northern architects, whether in Norway or Dalmatia, only began to translate their ideas into stone round about the time when the Romanesque style was capturing the European imagination, there are not a great many examples of this early church art left standing. But there are a sufficient number for purposes of study, and the case that Professor Strzygowski is able to make is a very convincing one.

To us chapter III is likely to be of especial interest, since it deals with half-timber churches, more than half of the illustrations being drawn from England. If modern half-timber is an affectation rising out of an ill-developed appreciation of the picturesque, ancient half-timber sprang from necessity: "Western Europe from Roman times was not rich enough in forests to provide wood for the full-timber building of earlier ages, which in Russia and still more in Finland has continued down to the present day. . ." Our surviving half-timber churches are sometimes as attractive as they are interesting, but the tower of Earl's Barton, reproduced as Plate XXXV, is such an interesting example of stone arranged so as to suggest woodwork that one hardly can bring oneself to consider its independent æsthetic merits.

Professor Strzygowski knows too much for it to be easy for him to compress any part of his knowledge into a small book, but this is only another way of saying that we can only seldom hope to get so much, of such quality, *in parvo*.

P.B.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 10..Anthroposophical Society, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. M. Ehrenfried Pfeiffer, "The Influence of Man on Crystallisation and on the Growth of Plants."

Anthropological Society, 52, Upper Bedford Place, W.C. 8.30 p.m. Miss J. Gaultier de la Verendry, "Folk Songs of Canada, Eskimo, Indian and French-Canadian."

British Architects, Royal Institute of, 9, Conduit Street, W. 8 p.m. Business Meeting.

Geographical Society, at the Aeolian Hall, New Bond Street, W. Mr. Leonard T. Scott, "The Saura Oases and the Niger from Timbuktu to Jebba."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz." (Lecture II.)

TUESDAY, JUNE 11..Asiatic Society, 74, Grosvenor Street, S.W. 4.30 p.m. Mr. Eldon Rutter, "The Arabians."

Empire Society, at Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Right Hon. Sir George Foster, "The New Internationalism."

Quekett Microscopical Club, 11, Chandos Street, Cavendish Square, W. 7.30 p.m. Mr. C. H. Oakden, "Various Forms of Photo-Micrographical Apparatus."

Roman Studies, Society for the Promotion of, Burlington House, W. 4.30 p.m. Annual General Meeting. Paper by Dr. Martin Nilsson.

University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VII.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. Robin Flower, "Life, History and Folklore of a Kerry Island." (Lecture IV.)

WEDNESDAY, JUNE 12..Eugenics Society, at Burlington House, W. 8 p.m. Discussion on "Would the general diffusion of a high degree of Intelligence be desirable" Speakers: Mr W. T. J. Gun and Dr. Bennie Dunlop.

Geological Society, Burlington House, W. 5.30 p.m. Dr E. Mackenzie Taylor, "Base Exchange, and its Bearing on the Formation of Coal and Petroleum."

Research Defence Society, at 11, Chandos Street, Cavendish Square, W. 3 p.m. Prof. Dr. A. V. Hill, "Enemies of Knowledge." (Stephen Paget Memorial Lecture.)

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz." (Lecture III.)

THURSDAY, JUNE 13..Historical Society, 22, Russell Square, W.C. 5 p.m. Alexander Prize Essay.

Optical Society, at the Imperial College of Science and Technology, Imperial Institute Road, S.W. 7.30 p.m.

University of London, at King's College, Strand, W.C. 5.30 p.m. Mr A. F. Meyendorff, "The Class-Struggle Idea in Current Soviet Legislation and Administration." (Lecture II.)

FRIDAY, JUNE 14..Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Physical Society, at the Imperial College of Science and Technology, South Kensington, S.W. 5 p.m. 1. Mr W. E. Pretty, "Pressure shifts in Line Spectra of Gases." 2. Messrs. A. S. M. Symons and J. Daley, "The Zeeman Effect for the Arc Spectrum of Gold." 3. Dr. W. Jevons, "The Band Spectrum of Lanthanum Monoxide."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz." (Lecture IV.)

At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Philip Noel Baker, "The Consequences of the Paris Pact for the Renunciation of War." (Lecture II.)

At University College, Gower Street, W.C. 5 p.m. Mr. Hector Corfiato, "French Gothic and Early Renaissance."

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FRIDAY, JUNE 14th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-hundred-and-seventy-fifth Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statement for 1928, and for the election of Officers, will be held, in accordance with the Bye-laws, on Wednesday, June 26th, at 4 p.m.

(By Order of the Council),

GEORGE KENNETH MENZIES,

Secretary.

SIXTH ANNUAL COMPETITION OF INDUSTRIAL DESIGNS.

The entries for this year's Competition have now been received and although, until they have all been received and classified, it is not possible to state the exact number of designs entered, it is quite evident the interest in the Competition is well maintained and that there will be a further increase this year in the number of competitors and designs. Last year there were 1,024 competitors and 3,126 designs. So far as can be ascertained at present the numbers this year will be 1,231 competitors and about 3,500 designs. There is a large number of entries for Textile designs which show an increase of about 300 on last year's figure of 959. As the number of Textile designs entered in 1927 was 487 the increase in the last two years is noteworthy. In the Advertising Section there is an increase of over 300 designs, so that this year's entries for Posters, Show-cards, etc., are 600 in excess of those of 1927. There is an innovation this year in the Pottery and Glass Section as 140 actual specimens of fired pottery have been entered. The numbers of entries for the various other Sections of the Competition are about the same as in previous years.

The judging of the designs and awarding of the various Scholarships and Prizes will take place in July, and the accepted designs will be on view at the Imperial Institute, South Kensington, S.W., from August 3rd to September 1st, Sundays included.

It is interesting to note that offers of Prizes for designs in connection with the Competition for 1930 have already been received from a number of important manufacturers.

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

WEDNESDAY, MAY 1ST, 1929.

THE RIGHT HON. LORD ASKWITH, K.C.B., K.C., D.C.L., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Mr. Morley Horder was a Vice-President of the Society, and a very distinguished architect who had taken part in much antiquarian and artistic work connected with architecture in this country. He had, moreover, been the architect of many great works but took an interest both in big buildings and in small ones. He was very keen about ancient cottages, a subject in which the Society was interesting itself so much at the present time. Mr. Morley Horder would describe the procedure which he thought very important when new houses or other buildings were going to be built, and which was rarely followed at the present time. Children loved to make models which they could pull to pieces. They liked building sand castles, even though those castles were destroyed by the incoming waves. That kind of thing was innate in human beings and possibly in some animals also. It would be of interest to hear how far back any system of making models not after but before a building was commenced was used, and whether before making the marvellous things which had been excavated at Ur of the Chaldees and elsewhere the kings with unpronounceable names had an idea of what was going to be built put before them in a model by the architects of those days.

The following paper was then read :—

BUILDING MODELS.

By P. MORLEY HORDER, F.S.A.

The announcement in the *Royal Society of Arts Journal* that I should speak on the subject of Building Models produced a very considerable amount of correspondence and printed matter from various individuals and firms who apparently make it their entire business to model buildings and estates for the use of architects and surveyors. I had not the least idea that there were so many firms engaged in this work. Their literature set forth the quite obvious fact that models are always much more readily understood than architects'

plans or a surveyor's plotting of an estate. The professional modeller is certainly right in saying that a model is always much more readily understood than a plan by a client, but it is even more important for the architect to look at his design in the solid and in relation to the adjoining buildings or the contours of his site. Architectural draughtsmanship applied to the concrete art of building is as often as not a delusion and a snare to the architect, and certainly to the client. The skilful illustrator can slur parts in an architectural scheme which often a rough model will ruthlessly expose, and the building may be made to appear very attractive by the addition of individual illustrator's tricks of shading and backgrounds and foregrounds that do not exist. The art of architectural representation has become almost a profession in itself, and the walls of the Architectural Room at the Academy are lined with architectural designs expressed by clever illustrators. They do, of course, represent very fine architecture in an interesting way, but the majority of the drawings are pictorial rather than representative of the actuality which presumably will materialise. It would be interesting to collect, and to have an exhibition of the drawings that exist of any buildings in England before the nineteenth century. The records of the architectural drawings of the Great Masters of Architecture make no attempt at representation as we understand it to-day, and I question, if such drawings were presented to a modern client, whether he would consider them for a moment. He certainly would not understand their architectural values and would need to have them "rendered," as they say, by a modern illustrator such as I have described. The drawings one associates with buildings which have become architectural exemplars were simply a scholarly and proportionate expression of the plan. Architectural draughtsmanship, as we understand it in these days, apparently did not exist before the eighteenth century, and it would almost seem as if all the really great buildings of the world were built on the spot without any detailed plans and from mere sketches. Mr. Martin Briggs has dealt very ably with the subject of Architectural Models from the historical point of view in *The Burlington Magazine*. He suggests that the history of the architectural model in England cannot be traced with any certainty beyond the seventeenth century, and although, as I have said, he is dealing with the matter only from a historical point of view, it is interesting that he quotes as the first definite reference to models a passage from Sir Henry Wotton's "Elements of Architecture," published in 1664. This quotation is a perfect text for anything I have to say on the right use of models.

"Let no man that intendeth to build, settle his Fancie upon a draught of the Worke in paper, how exactly soever measured, or neatly set off in perspective; And much less upon a bare plante thereof, as they call the Schiographia or Ground lines; without a Modell of Type of the whole structure, and of every Parcell and Partition in Pasteboard or Wood. Next that the said Modell bee as plaine as may bee, without colours or other beautifying, lest the pleasure of the Eye preoccupate the Judgement; which advise omitted by the Italian

Architects, I find in Philippe de l'Orme, and therefore, though France bee not the Theatre of best Buildings, it did merit some mention of his name.

"Lastly, the bigger that this Type bee, it is still the better, not that I will perswade a man to such an enormity as that Modell made by Antonio Labaco, of Saint Peter's Church in Rome, containing 22 foot in length, 16 in breadth, and 13 in heighth, and costing 4184 crowns; the price in truth of a reasonable Chapell; yet in a Fabrique of some 40 or 50 thousand pounds charge, I wish 30 pounds at least layd out before hand in an exact Modell; for a little misery in the Premises may easily breed some absurdity of greater charge in the Conclusion."

Sir Christopher Wren used models for such buildings as Pembroke College, Trinity College and St. Paul's. We read in *The Parentalia*: "Some Persons of Distinction, skill'd in Antiquity and Architecture, express'd themselves much pleased with the Design, and wished to see it in a Model; the Surveyor comply'd with their Desires as well as their own, and made a very curious large model in wood, accurately arought, and carv'd with all its proper Ornaments." Sir John Soane used models, far more than any other Architect, and left a large and very interesting collection in the Soane Museum. These models of Soane's come nearer to my idea of the purposes of a model. They are perhaps over-elaborate and unnecessarily expensive, but you do feel that they were made as much for his own assurance as to the design as for the benefit of his clients.

A few years ago Lady Constance Hatch made a very interesting collection of architectural models, and read a paper thereon in the Manchester City Art Gallery. One of the most interesting models shown was "the one made by Wren's contemporary, Mr. March, for William Cavendish, first Duke of Newcastle, who decided in his eighty-third year to build a house for himself on the site of Nottingham Castle. To his Grace plans were 'just a tissue of meticulous and inconsequent lines, conveying neither sense nor shape.' As we all know, this eccentric nobleman was merely voicing the impressions of many of our own clients unaccustomed to working drawings and those of the untrained public as a whole." Judging by the list of models which Lady Hatch compiled for her address, and which she very kindly lent me, she must have taken enormous pains to locate all the known examples of building models. A great number of the models recorded in Lady Hatch's very exhaustive list are, of course, merely recording models made immediately after the erection of the buildings, or much later, as interesting representations of well-known architecture, but I was surprised to see quite a number made for the purposes of showing the patron what sort of building was to be expected. In the course of my experience I have come across, in old houses of about the late eighteenth century, quite excellent models, showing with scholarly knowledge the details and proportions of the additions, generally to a much earlier period house. I have in my possession one such model of the garden front of a house in Dorsetshire which was found in the attic of the house some years ago. I suggest

advisedly that Lady Hatch's researches should be turned to some really useful account, and an attempt be made to collect all the contemporary models that can be found, and that the Architecture Club should have an exhibition of these, together with examples of models from which modern buildings have been built. I am sure that such an exhibition would be of the greatest interest to the public, and encourage them to be more observant and to see a building from all sides before they accept a representation which, as often as not, does not tell the whole truth at the outset. Such an exhibition would be encouraged, I am sure, by all the Schools of Art and would be of the greatest interest to their students. This exhibition might be varied by shewing stereoscopic representations on the screen of interesting buildings. In a way, the pictorial drawings and the model might well be compared with the flat picture and the stereoscopic picture on the screen. It is only in recent years that a vastly greater number of people have had to face the problem of building for themselves, and therefore there is a much larger public of necessity interested in building. For one person who finds any interest in walking round the Architectural Room of the Academy, a thousand will take an excited interest in a real house exhibited at the Ideal Homes or other Exhibition. There are comparatively few people who have sufficient technical knowledge to follow an architectural plan and elevation and judge their proportionate values, and therefore, to interest the public in a room hung with architectural drawings, the majority of them must be really more suitable for the black and white or Water Colour Room of the Academy There is, of course, a considerable public who are interested in topographical water colours for their charm of draughtsmanship or associate interest. But even these find an exhibition of purely architectural designs very trying in their effect, and they are really only interested in such drawings as are effective from the pictorial point of view rather than for their architectural values. Architectural forms and details in the round are at once arresting. Sculpture has very little meaning apart from architectural setting if it is agreed that it is really only a complementary art to architecture—the sculptors who recognise this must be severely handicapped unless they have had a considerable architectural training. If, instead of making their sculpture from drawings, they were given models to work from, their tasks would be very much simpler, and they would find that a great deal of unnecessary detail could be omitted. This reminds one of one of the greatest values of models in the elimination of every unnecessary detail that does not contribute to the chief aim of architectural form, namely, proportion. This really is an answer to the criticism that modelling is expensive. As a matter of real fact, the results in the hands of educated minds must make for the greatest economy in the use of materials. The practice of using models in the right way in an architect's office will very soon demonstrate how absolutely true this is, and it will be found astonishing how much in the way of expensive detail which seemed necessary in the flat drawing can be eliminated

when the form of the building has been reduced to its simplest outlines. Modelling, to be really useful in an architect's office, should start after the sketch ideas are produced, and should continue until the completed design becomes the builder's working drawing. In fact, the usefulness of models in an architect's office depends on having a draughtsman skilful enough to set up quickly in some form of paper board the elevations of any plans for consideration and criticism. The material used should be of such a nature that it can be easily altered until the form seems as direct and expressive as it can be in relation to the building materials proposed. In my experience I have found clients welcome this method of enabling them really to visualise and become familiar with the form of the building they have commissioned, and generally ask for the model to be carried even more into detail than is necessary. They certainly take a much more intelligent interest in the design than in any drawing, and see at once the arguments for not doing things which are unsuitable by realising the consequences so clearly made manifest in the concrete form exhibited in the model. It obviously does take longer to make a model than to set up elevations on paper; on the other hand, how often does the conscientious architect look at his complete working drawings, which have probably taken weeks to make, and suddenly realise that they have not worked out as he anticipated. The rough model might have brought him to this conclusion before so much labour had been expended. The rough preliminary model is particularly valuable in connection with the contours of a difficult site. Useful variations often suggest themselves in the design of a house if the garden is approximated to in the model. Indeed, every site seems to have its particular conditions and relationship to aspect, views and approach, all of which can be visualised much more clearly in elevations projected in solid form. Architects of great imagination and power may say we can visualise all this in perspective sketches and all this modelling is quite unnecessary labour. But even these talented men will find that their clients will thank them for expressing what they wish done in this way, and they are much more likely to convince them. Surely it is the rarest thing to see a modern building which is so convincing in its growth from its site and its charm of material that such aids as I am suggesting can be neglected by the majority of the profession. Apart from the question of whether modelling can be used with advantage for all the hundred and one problems which present themselves in an architect's office, there can be no question in my mind that the task of an assessor in great competitions would be simplified, and the results would be vastly more satisfactory if, instead of decisions being taken on working elevations or elaborate perspectives, the final decision of the assessors should be confirmed by models, complete enough to show the relation of any building in a town to its site and adjacent buildings. The housing and tabulating of drawings of executed buildings is a serious problem in an architect's office. He is continually wishing to have a bonfire, as no architect,

I am sure, ever wishes to refer to his past misdeeds. But unfortunately they have to be kept for possible reference, and if he begins to burn records of any one job, he nearly always finds that it is just those the client asks him to refer to. The difficulty of housing models is of course a much greater one. But if they are made in the way I suggest there is really no need to keep them, as all the points which have been made in a model are finally registered in the working drawings. A few of the more important and finished models are naturally preserved, but the majority either fall to pieces or are destroyed for the reasons which I have given. The rather miscellaneous collection of slides illustrating models which I show to-night are not therefore in any way suggestive of any particular architectural methods, but rather to shew the varying purposes for which models can be usefully made. If anything I have had to say about the method of architectural representation will further the beauty in building, I shall be grateful. The surpassing beauty of England is in danger from every form of ill-considered design and the use of unsuitable material. Housing, we are told, is still a pressing problem, and large areas of land are still to be covered with groups of standardised houses. The real difficulty is the grouping and patterning of the units to the contours of the site. To assemble all the units on the roads in model form, and decide the points of emphasis to save such large schemes from monotony on the one hand and from really meretricious variety on the other, can only be done satisfactorily in my opinion by way of a small scale model, more especially where the ground is undulating. The old village was not produced by any methods such as we associate with an architect's office. It was an uncontrolled growth of craftsmanship interpreted with natural local materials. The conditions which produced this beauty have gone, and for this reason I enter a plea for their preservation. Mass production has taken the place of the old methods, and economic necessities require haste and the use of less sympathetic materials. But forms can still be controlled and standardised into beauty, but only by the most careful consideration of the massing and architectural connection of the units into less self-conscious and assertive forms than are littering the countryside to-day.

DISCUSSION.

Mr. Morley Horder, in reply to a member of the audience, who asked how the models were made, and what materials were as a rule employed, said that as the models must be so made that they could be easily pulled about and altered structurally, he always used some form of paper board.

The Chairman said Mr. Morley Horder had given a very interesting lecture. The Secretary of the Society had been kind enough to give him a reference to the review of a book by Major R. W. G. Hingston on "Problems of Instinct and Intelligence," with reference to the remarks he made in opening the meeting about

even lower animals than man going in for model making. It was very possible that valuable lessons might be learned from the study of the behaviour of animals and insects in that connection. Major R. W. G. Hingston, in his work, *Problems of Instinct and Intelligence*, had told of a case where a wasp had deliberately planned out the whole of her nest before she built it : " One morning, in a deserted house, I happened to see on a whitewashed wall an example of this mason's work. The wasp had completed two of her cells and was about to commence the third. But here is the point which literally amazed me. In addition to the two completed chambers, the wasp had mapped out the scheme of architecture for all the subsequent cells of her nest. Before me on the wall was a definite plan, a mapping out of the final structure, made, I have no doubt, for the same purpose that the human architect maps out a house. . . . At the very commencement of her labour she had pre-arranged for the whole work. This, I am confident, implies intelligence."

Mr. Horder had shown how within the last few centuries a model had very occasionally been made before a building was put up, and had been of service. Personally, he thought that a great many portions of this country might have been differently covered with Government houses if a plan had been made of the countryside with the type of houses and a sketch of the contour laid out beforehand to facilitate criticism. That was done in connection with a very important structure in London. When Sir Edward Lutyens designed the Cenotaph in Whitehall, he first erected a full-sized model before the actual building was made, so that the public could see what it would look like. The public appreciated it and the result was the Cenotaph.

The lecturer alluded at the end of his remarks to the important point of the future housing of this country, and spoke about the slums. All three political parties were talking about what they were going to do with the slums and what they were going to do about more housing. The amount of money which would have to be spent, and the difficult problem of ejecting people who did not want to leave and transferring them to another site, and of pulling down houses and re-erecting more, would be facilitated if some models were made beforehand to enable the ordinary man to understand better what the idea was with reference to surrounding buildings, streets, railways and everything else than was possible by mere plans upon paper. He fancied that models could be produced with little expense and with vast advantage, and he was glad Mr. Morley Horder had made a protest as to the importance of showing models and of letting people judge before an irrevocable decision was taken. Large sums of money were spent at the present time in putting up buildings which later on everyone might desire to pull down but which would be too expensive to scrap.

In modern Berlin there was a very big building with an enormous cross at the top of it. It was said that cross was added because the plan on the paper was sent to the Kaiser, who put a mark against it, and the architect, who did not dare to question what the Kaiser meant by it, took it to mean a cross, and put an enormous cross on the top of the building. Now everyone would like that cross taken down ; probably the Kaiser himself, who at any rate pretended to be artistic, if he had seen a model with that heavy cross on the top of the building, would have said that he did not mean that or that, at any rate, it should be made smaller and not correspond with the way in which his pencil had wandered over the paper.

Mr. John B. Thorp said he had made a study of model-making the whole of his life, and only wished that architects would properly appreciate the value of models. A short time ago he made a model, for a well known architect at Birmingham, of a high tower which had a finial at the top. On paper that finial looked quite in proportion,

but when the architect looked at the model he saw that in the real building the finial would appear too small when it was looked at from the natural eye level, and he made the finial half as big again. It looked out of proportion on paper, but in the real thing it looked exactly in proportion. That could never have been done had the tower been actually erected with the smaller finial.

The lecturer had said that models were made in the 16th and 17th centuries, and personally he understood that in the 17th century models were used a great deal more than plans. Many people were familiar with the very fine model of Wren's first design for St. Paul's, which was at present kept in an out-of-the-way place in that cathedral, and which many people were therefore unable to see. It was some fifteen to twenty feet long and made of wood. It would be of advantage if the Society would use its influence to have that model removed and put in the London Museum where it could be seen by the general public.

An architect as well as a layman could appreciate a model where he could not appreciate a flat drawing. Some time ago he made a model for an architect of a very complicated roof and told the architect that it would not work. The architect did not believe him until he came and saw the model for himself, and it was only in that way that the mistake was discovered.

Mr. Morley Horder said that he hoped that the Architects' Club would urge the Chapter of St. Paul's to allow them to exhibit the model referred to by Mr. Thorp.

On the motion of the Chairman a vote of thanks to the lecturer was carried unanimously, and the proceedings then terminated.

OBITUARY.

H.H. Sir Bhawani Singh Bahadur, K.C.S.I., Maharaj-Rana of Jhalawar.—The Maharaj-Rana of Jhalawar, who died suddenly while on his way to Europe in April last, was born on September 4th, 1874, and was the son of Thakur Chatrasalji, of Fatehpur. He was educated at the Mayo College, Ajmere, and at the age of 25 was selected by the British Government to occupy the throne of Jhalawar, which had become vacant owing to the deposition for maladministration of the former ruler, Zalim Singh. The severe famine of 1899, the year following his elevation to the throne, gave the new ruler an opportunity to show his mettle in the supervision of relief measures and the personal interest thus shown in the welfare and good government of his people was continuously maintained throughout his life.

The Maharaj-Rana's interests were largely in the direction of science, art and literature, and these interests were stimulated by a succession of visits to Europe, which afforded him opportunities of forming personal relationships with a number of persons of scientific or literary eminence in this country. He was responsible for many reforms in the State of Jhalawar, including the establishment of a two-chamber Legislature and the grant of municipal self-government. He also furthered the cause of education and enlightenment by the foundation of many new schools for boys and girls, the Rajendra Literary Institute, the Shakespeare Society of Jhalawar, and other similar institutions. His Highness had been a Fellow of the Royal Society of Arts since 1912 and was a member of a large number of literary and scientific Societies in this country, where his attractive personality gave him a wide circle of friends, both in the social and intellectual world. He is succeeded by his only son, Kumar Rajendra Singh.

NOTES ON BOOKS.

IMMIGRANT BACKGROUNDS. Henry Pratt Fairchild, Editor; by Fifteen Contributors. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Limited. 13*s*. 6*d*. net.

First glances, by a casual turning over of the pages, show a notable conciseness combined with clearness of expression, so that the early impression is distinctly favourable. In our time, a preface to a new book is an almost universal feature, and, in addition, there is often a dedication and an adulatory introduction by a more or less well-known person: hence our after-glance at the place, where the preface usually is, was quite in order, but we found no formal preface: not even as much as Abernethy's notably concise three-word preface, "Read my Book." Abernethy's volume on surgical experiences was received with acclamation, and in a quite friendly spirit it was usually termed "My Book" in honour of the concise preface and of Abernethy's incisive lucid style. The ingenious author of the political skit, "All the Talents," which was published in the pre-Victorian era that gave us the writings of Abernethy, satirised prefatory adulations and superfluities by a long and grovelling dedication to the Emperor of China. There is, however, a covert admission that the writer had no knowledge of his Majesty, but realised "the importance of a high title at the front of a book."

In the first essay, "What is an Immigrant Background"? pp. 1 to 13, Professor Fairchild, who occupies the chair of Sociology in New York University, tells us what we are to understand by the term. He says (p. 1) "that the new political orientation is scarcely more than an incident." . . . "It is the environment in its entirety which he has left behind that constitutes the background."

Before briefly touching on the principal points of Professor Fairchild's new and important contribution to Sociology we may revert to our own discursive commencement and indicate the notably useful lesson in book construction which he gives to the literary world. He shows that preface and introduction may well be set aside in many cases; the first sentences of the book itself indicating its nature and aims.

In the 269 pages which constitute the book under notice we find important new strains of thought for the economist, the statesman and the general reader; the essayists who co-operate with Professor Fairchild working in that general spirit of unity which makes reading easy and profitable.

Our endeavour to convey some partial notion of the varied store of facts and opinions as to fundamentals in comparative sociology must consist of a few exemplary extracts, with remarks.

On p. 268, under the general heading "Other Peoples" and sub-heading "The Turks," we read:- "Until the revolution of the young Turks in 1908, Turkey had been an absolute monarchy. . . . In 1922 the nationalist government . . . abolished the Sultanate." Thus the great historical event of 1453, which drove learning westward, has its incidence changed by the Great War.

Let us now turn to pp. 240 and 241, the conclusion of an essay in which the Editor of *The Forum* (H. G. Leach) studied the background of the Swedes. He seems to dread the thought of such material as may be expected in the compatriots or descendants of such men as Gustavus Adolphus, Scheele, and Buselius sinking in a welter of "slang, jazz, chewing gum, mileage-tablets, and the movies"; also he makes suggestions for the utilisation of such material. Perhaps we can summarise all that is to be said in the words, Read Fairchild's Book.

Everyday Art at School and Home. By D. D. Sawer. London: B. T. Batsford, Ltd. 12s. 6d. net.

It would be rash of the highbrow critic to "turn up his nose" at this book, with its little texts and sentimental poems. It would be rash, because it needs a special talent for a grown-up to retrace his (or her) steps so as to enable him (or her) to guide the young through their early stages of artistic expression. Miss Sawer has this special talent. Some books of this class are bad specimens of a good type; "Everyday Art" is almost the opposite, namely a good specimen of a dangerous, if not necessarily bad type. In short, Miss Sawer has a second talent: that of expressing herself in words and pictures, and so communicating her personality to her readers. Thus she disarms the critic, who would often challenge the letter of her law if its spirit were not entirely sympathetic.

Indeed, the present reviewer has never known a generous spirit bubble over into print with such happy effect. There is, of course, no attempt made here to turn children into little Michel-Angelos. But one cannot help hoping, and almost believing, that with the aid of this book parents and teachers will turn them into more sensitive and civilised people than their likes of the previous generation.

An excellent chapter deals with lettering, a subject that I would not have dreamed of in the wildest dreams of my own childhood as actually an art: it was clearly an engine of penance. Three chapters together are called: "Drawing exercises to develop interest in home life." A very good motive, for children take home life too much for granted, or think of it only as a beginning and not also as an end.

So in spite of Miss Sawer's Neo-platonic-evangelical-pantheism one must recommend her book very highly indeed.

P. B.

EXHIBITION OF APPLIED ART.

Exhibition of Arts and Crafts, L.C.C. Central School of Arts and Crafts, Southampton Row.- The problem of culture, in its widest aspect, is that of giving all human beings a footing, at least, on a high common plain of sensibility. It should not be too much to ask that in the modern world all the inhabitants of a progressive country should speak the same language. That they should do so is just and expedient, and an upshot to be hastened by all the reasonable intellectual and economic influences at the disposal of society.

Arts and crafts may be regarded as both a sign and an expression, as both discipline and emancipation. Talent can be fostered, and good taste can, to an important extent, be inculcated even where there is little talent. The latter function, the inculcation of good taste, is being performed with increasing effectiveness by the technical institutes of London. These metropolitan centres of technique and culture are being more and more appreciated by thousands of people, and the present exhibition does great credit, not only to the students, but also to their instructors.

There is a wide range of exhibits. The pottery is interesting: M. K. Vowles, as usual, shows an artist's feeling for colour, and is run close by S. Peereboom with a desirable jug. A. Goodborn, with rather more abstract patterns, is good: so is J. Grant. W. Turner and L. Cookes are so able that one hopes they will turn from *genre* in porcelain and apply their talents to more sympathetic ends.

The metal work shows nothing if not a very honest striving to compromise between utility, originality and sound traditions of design. Note the work of C. W. Gilbert and A. Nimmo, the small engraved silver salver by A. L. Wyatt, and the tea-pot by M. Fells.

Turning to book production, we find that the little printing on view is good,

and that there is quite a wealth of admirable binding. Some of these names are already known, but not as widely as they ought to be. Miss E. Greenhill's work is excellent, or when not excellent, enterprising: her cover for a volume of Blake is creative but not altogether right. P. A. Polak and C. Cresswell are fine craftsmen; B. Bewsher is an admirable scribe.

Among exhibitors of patterns for textiles, Goetzer Steyn is conspicuous—evidently, by the way, a many-sided person. M. Yonge seems not inferior; there is to-day a goodly company of clever workers in this department.

It is another story when we leave the crafts and come to the fine arts, but one hardly expects to find more than evidences of pains taken in the pictures and statues shown by students in any school whatsoever. The exhibition closes on June 26th. P. B.

GENERAL NOTE.

R.I.B.A. SCHOLARSHIPS IN ARCHITECTURE.—The Royal Institute of British Architects offer for award in July, 1929, two Maintenance Scholarships in Architecture of a maximum value of £100 per annum, tenable from October, 1929.

The Scholarships will be tenable, in the first instance, for one year, and will be renewable for two further periods of one year each. They are intended to enable students who have not the necessary means to attend an approved course at one of the Schools of Architecture recognised for exemption from the R.I.B.A. Examinations. Students who are already taking such a course are not eligible to apply for a Scholarship.

Particulars and forms of application may be obtained from the Secretary to the Board of Architectural Education, R.I.B.A., 9, Conduit Street, London, W.1.

The closing date for the receipt of completed applications is the 1st July, 1929.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, JUNE 17..University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz." (Lecture V).
At University College, Gower Street, W.C. 5.30 p.m. Prof. Martin P. Nilsson, "Homer and Mycenæ." (Lecture I).

TUESDAY, JUNE 18 Imperial Institute (Cinema), South Kensington, S.W. 2.15 p.m. Mr. Clifford Collinson, "Trading with South Sea Cannibals."
Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Sir Hubert Llewellyn Smith, "The New Survey of London Life and Labour."
University of London, at King's College, Strand, W.C. 5.30 p.m. Sir Bernard Pares, "Contemporary Russia." (Lecture VIII).

WEDNESDAY, JUNE 19..British Academy, Burlington Gardens, W. 5 p.m. Dr. Camillo Pellizzi, "Romanticism and Regionalism."
Imperial Institute (Cinema), South Kensington, S.W. 2.15 p.m. Mr. A. E. Smith, "London—the Imperial Port."
Meteorological Society, 49, Cromwell Road, S.W. 5 p.m. 1. Dr. F. J. W. Whipple, "Potential Gradient and Atmospheric Pollution: the Influence of 'Summer Time.'" 2. Mr. A. J. Bamford, "Vertical Air-currents as Measured by Pilot Balloons." 3. Dr. George Slater, "Studies on the Rhone Glacier, 1927. The Relationship between the Average Air-temperature and the Rate of Melting of the Surface of the Glacier."
University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. Wildon Carr, "The Philosophy of Leibniz" (Lecture VI).
At University College, Gower Street, W.C. 5.30 p.m. Prof. Martin P. Nilsson, "Homer and Mycenæ." (Lecture II).

THURSDAY, JUNE 20..Chemical Society, Burlington House, W. 8 p.m. 1. Mr. H. B. Baker, "Manipulation in Intensive Drying." 2. Mr. W. A. Bone, "Notes on Intensive Drying of Gaseous Media." 3. Mr. H. J. Emeléus, "The Light Emission from the Phosphorescent Flames of Ether, Acetaldehyde, Propionaldehyde and N-Hexane." 4. Messrs. A. J. H. Houssa, J. Kenyon and H. Phillips, "The Relative Configuration of d-β-Octanol and its Dextrorotatory Halides. The Interconversion of the Optically Active β-Octanols by a New Method."
Constructive Birth Control and Racial Progress, Society for, at the Essex Hall, Essex Street, Strand, W.C. 8 p.m. Mrs. Cora B. Hodson, "Birth Control Clinics in the United States."

FRIDAY, JUNE 21. Imperial Institute (Cinema), South Kensington, S.W. 2.15 p.m. Colonel J. A. Haddick, "India, Past and Present."
University of London, at King's College, Strand, W.C. 5.30 p.m. H. E. Monsieur J. Gennadius, "Sources of the History of the Greek War of Independence."
At the London School of Economics, Houghton Street, W.C. 5 p.m. Mr. Philip Noel Baker, "The Consequences of the Paris Pact for the Renunciation of War." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Prof. Martin P. Nilsson, "Homer and Mycenæ." (Lecture III).
5 p.m. Prof. A. E. Richardson, "French Late Renaissance Architecture."

JOURNAL OF THE ROYAL SOCIETY OF ARTS.

No. 3,996. VOL. LXXVII.

FRIDAY, JUNE 21st, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. 2

FINANCIAL STATEMENT FOR 1928.

The following statement is published in this week's *Journal* in accordance with Sec. 25 of the Society's Bye-laws:—

INCOME AND EXPENDITURE ACCOUNT.

January 1st to December 31st, 1928.

Dr.

	£ s. d.	£ s. d.
To *Journal*, including Printing Publishing and Advertisements	3,556 3 1	
" Library and Bookbinding	80 0 0	
" Medals: Albert .... 21 10 6; Society's .. 24 10 0	46 0 6	
" Cantor Lectures	131 7 4	3,813 10 11
" Expenses of Examinations		13,598 19 4
" House: Rates and Taxes	375 2 10	
Insurance, Gas, Coal, Expenses and Charges incidental to Meetings	706 10 5	
Repairs	230 17 2	
Installation of Cinematograph	106 12 7	1,419 3 0
Office Expenses:— Salaries, Wages, and Pensions	4,406 8 7	
Stationery and Office Printing	560 5 0	
Postages, Parcels, and Messengers' Fares	281 1 0	5,247 14 7
Committees:— General Expenses		35 15 6
Industrial Art Competition		516 2 5
Interest on Bank Overdraft		92 11 11
Superannuation Fund		524 8 0
		£25,248 5 8

Cr.

	£ s. d.	£ s. d.
By Subscriptions	6,084 19 0	
" Life Compositions	553 10 0	6,638 9 0
" Interest and Dividends on Society's Investments	373 9 10	
" Ground Rents	365 9 0	
" Interest, Dividends, and Ground Rents from Trust Funds for General Purposes	496 4 8	
Do. from Building and Endowment Funds	22 7 5	1,257 10 11
" Sales, etc.:— *Journal*	195 0 1	
Do. Advertisements	750 0 0	
Cantor Lectures	38 10 8	983 10 9
Examination Fees and Advertisements in and Sale of Examination Papers		15,468 8 0
Charges for Expenses for the use of Meeting Room		362 0 0
Rent of Cellars		75 0 0
Balance, being Excess of Expenditure over Income transferred to Capital Account (see Balance Sheet)		463 7 0
		£25,248 5 8

TRUST INCOME AND EXPENDITURE ACCOUNTS.

Dr.

	£	s.	d.	£	s.	d.
To ART CONGRESS STUDENTSHIP—						
Interest on Investments	24	14	9			
Prize and expenses	61	16	6			
Balance due to the Society				37	1	9
Balance forward..........				1,146	13	5
Carried forward				£1,183	15	2

Cr.

	£	s.	d.	Trust Accumulations, Dec. 31st, 1928 £	s.	d.
JOHN STOCK TRUST						
By Balance, January 1st, 1928 ..	49	17	3			
,, Interest on Investments	3	10	2			
				53	7	
NORTH LONDON EXHIBITION TRUST—						
,, Balance, January 1st, 1928 ..	70	15	0			
,, Interest on Investments	6	14	10			
	77	9	10			
Less Prizes for Industrial Design	43	4	0			
				34		
DR. ALDRED'S TRUST—						
Balance, January 1st, 1928 ..	73	1	8			
Interest on Investments	7	14	5			
				80	16	
THOMAS HOWARD'S TRUST—						
Balance, January 1st, 1928 ..	77	17	8			
Interest on Investments	19	19	8			
				97	17	
MULREADY TRUST						
Balance, January 1st, 1928 ..	35	15	5			
Interest on Investments	5	11	0			
				41	6	5
DR. SWINEY'S TRUST—						
Balance, January 1st, 1928 ..	160	0	0			
Ground Rents (Income from)	180	0	0			
	340	0	0			
Less Cost of Cup	100	0	0			
,, Transfer to Society's Income and Expenditure a/c	140	0	0			
				100	0	0
FRANCIS COBB TRUST						
Balance, January 1st, 1928 ..	54	0	1			
Interest on Investments	8	18	10			
LE NEVE FOSTER PRIZE TRUST—						
Balance, January 1st, 1928 ..	24	5	4			
Interest on Investments	6	0	6			
FOTHERGILL TRUST						
Balance, January 1st, 1928 ..	30	13	11			
Interest on Investments	13	12	5			
				44	6	4
BENJAMIN SHAW TRUST—						
Balance, January 1st, 1928 ..	27	10	8			
Interest on Investments	4	13	6			
				32	4	2
CANTOR TRUST—						
Interest on Investments		2	0			
Ground Rents (Income from)	141	0	0			
	278	2	0			
Less Transfer to Society's Income & Expenditure a/c	278	2	0			
				—		
DAVIS TRUST—						
Interest on Investments	78	2	8			
Less Transfer to Society's Income & Expenditure a/c	78	2	8			
				—		
SIR GEORGE BIRDWOOD MEMORIAL TRUST—						
Interest on Investments	36	15	0			
Less cost of Sir E. Gait's Lecture (including Printing)	36	15	0			
				—		
RUSSIAN EMBASSY PRIZE TRUST						
Balance, January 1st, 1928 ..	25	0	0			
Interest on Investments ...		0	0			
				30	0	0
DR. MANN TRUST—						
,, Balance, January 1st, 1928 ..	85	10	1			
,, Interest on Investments	51	8	6			
	136	18	7			
Less Paid for Lectures	80	8	4			
				56	10	3
Carried forward				663	18	7

TRUST INCOME AND EXPENDITURE ACCOUNTS—*continued.*

	£	s.	d.
Brought forward	1,183	15	2
	£1,183	15	2

	£	s.	d.	£	s.	d.
Brought forward				663	18	7
By OWEN JONES MEMORIAL TRUST—						
Interest on Investments	15	13	4			
Less Prizes awarded	15	13	4	—	—	—
THOMAS GRAY TRUST—						
„ Balance, January 1st, 1928 ..	383	2	1			
„ Interest on Investments	272	1	2			
	655	3	3			
Less Paid for Prizes and Essay	135	6	8	519	16	7
TRUEMAN WOOD LECTURE TRUST—						
„ Interest on Investments ...	32	10	10			
Less cost of Dr. Jean's Lecture (including Printing)	32	10	10	—	—	—
				£1,183	15	2

1929 - Jan. 1. By Balance brought forward £1,146 13 5

BALANCE SHEET. December 31st, 1928.

	£	s.	d.	£	s.	d.
Capital Account –						
As on January 1st, 1928	75,728	11	7			
Donations *re* Building Fund	8	9	4			
	75,737	0	11			
Less Income and Expenditure Account Balance ..	463	7	0			
				75,273	13	11
Sundry Creditors				822	4	0
Bank Overdraft				6,504	8	11
Industrial Art Fund (Donations received and not yet expended)				348	6	8
Trust Funds–						
Capital Account	25,410	6	0			
Accumulations under Trust Income and Expenditure Account	1,146	13	5			
				26,556	19	5
				£109,505	12	11

	£	s.	d.	£	s.	d.
Freehold Premises 18 and 19 John Street, as on December 31st, 1923 ..				*50,392	16	7
Books, Pictures, etc.				10,000	0	0
Investments (see schedule)				17,481	8	5
Subscriptions outstanding				2,144	11	0
Sundry Debtors and Ground Rents outstanding				1,586	10	11
Paid on Account of 1929 Examinations				2,400	0	0
Trust Funds –						
Investments	25,410	6	0			
Ground Rents, etc	90	0	0			
				25,500	6	0
				£109,505	12	11

PRESERVATION OF ANCIENT COTTAGES FUND.

	£	s.	d.
Donations etc. received to date	6,796	14	1
	6,796	14	1

	£	s.	d.	£	s.	d.
£3,541 18 3 4% Consolidated Stock	3,000	0	0			
Hampstead Garden Suburb Debenture Stock	55	0	0			
Amount paid to preserve Cottages at Worthing..	60	0	0			
Expenses, printing, postage, etc.	389	4	4			
Cash at Bank	3,292	9	9			
				6,796	14	1

We have audited the above Accounts and Balance Sheet for 1928 *with the books, accounts and vouchers relating thereto, and certify them as being in accordance therewith. We have verified the Bank Balances and investments.*

KNOX, CROPPER & CO.,

Chartered Accountants.

Spencer House, South Place, E.C. 2.
5th June, 1929.

* Towards this amount £43,506 13s. 2d. has been received in subscriptions from Fellows of the Society and others, and the excess of income over expenditure for the years 1922-28 amounted to £2,904 14s. 11d. There is therefore still a deficit of £8,981 8s. 6d. on the Building Fund, and the Council earnestly appeal to Fellows to assist them in clearing it off.

SCHEDULE OF THE SOCIETY'S INVESTMENTS.

		Standing in the Books at a Value of
	Ground-rents (amount invested)	£10,496 2 9
£217 0 0	Great Indian Peninsula Railway 4 per cent. Guaranteed Debenture Stock	157 0 0
£500 0 0	New South Wales 4 per cent. Stock	445 0 0
£500 0 0	Canada 3½ per cent. Stock	430 0 0
£100 0 0	Queensland 4 per cent. Stock	97 0 0
£530 10 1	New South Wales 5 per cent. Stock	514 11 0
£500 0 0	Natal 4 per cent. Stock	445 0 0
£321 15 9	Metropolitan Water Board "B" Stock	209 3 0
£6 0 0	New River Company Shares	6 0 0
£3,408 14 6	India 3½ per cent. Stock	2,181 11 8
£500 0 0	South Australia 4 per cent. Stock	500 0 0
£2,000 0 0	War Loan 5 per cent.	2,000 0 0
		£17,481 8 5

The Market value of the above investments on December 31, 1928, was £17,752 11 9

TRUST FUNDS INVESTMENTS SCHEDULE.

		Stock held.	Value at date of Bequest or Transfer.	Value on Dec. 31, 1928
Alfred Davies Bequest	£1,953 0 0	Great Indian Peninsula Railway 4 per cent. Guaranteed Debenture Stock	£1,800 0 0	£1,542 17 0
Dr. Swiney's Bequest	4,477 10 0	Ground-rents (amount expended)	4,477 10 0	4,477 10 0
Dr. Cantor's Bequest	2,695 11 3	Do. do. do.	2,695 11 3	2,695 11 3
Mulready Trust	111 0 9	5 per cent. War Loan	109 10 1	114 1 10
Howard Trust	571 0 0	Metropolitan Railway 3½ per cent. Stock	510 9 5	371 3 0
Owen Jones Trust	522 3 2	India 3 per cent. Stock	423 0 0	315 18 0
Dr. Cantor's Bequest	3,273 16 6	Do. do.	2,573 10 0	1,980 13 0
	648 19 7	Bombay & Baroda Railway Guaranteed 3 per cent. Stock		671 14 0
J. Murray and others, Building Fund	20 16 4	India 3½ per cent. Stock	20 10 0	14 13 6
	38 11 0	5 per cent. War Loan	54 18 0	39 12 0
Francis Cobb Trust	255 14 1	New South Wales 3½ per cent. Stock 1930-50	250 0 0	194 6 9
Le Neve Foster Trust	140 3 1	3½ per Cent. Conversion Loan	100 0 0	111 1 6
	42 2 1	5 do. War Loan	40 0 0	43 5 0
John Stock Trust	70 4 0	5 do. do.	100 0 0	72 2 0
Shaw Trust	93 12 0	5 do. do.	129 6 8	96 3 0
North London Exhibition Trust	134 17 0	5 do. do.	184 15 0	138 11 0
Fothergill Trust	272 7 6	5 do. do.	374 0 0	279 17 0
Aldred Trust	154 8 0	5 do. do.	210 17 6	158 13 0
Endowment Fund	394 7 0	5 do. do.	525 2 3	405 4 0
"Trueman Wood" Lecture Endowment Fund	929 15 8	3½ do. Conversion Loan	654 18 0	736 17 0
Sir George Birdwood Memorial Fund	734 19 9	5 do. War Loan	674 0 0	755 4 0
Russian Embassy Prize	100 0 0	5 do. do.	91 9 3	102 15 0
Mann Trust	1,028 9 2	5 do. do.	900 0 0	1,056 15 0
Thomas Gray Memorial Trust	9,047 18 9	3½ do. do. Conversion Loan	7,000 0 0	7,170 10 0
Art Congress Studentship	1,000 0 0	Canada 4 per cent. Stock	1,000 0 0	910 0 0
	112 0 0	Bengal-Nagpur Railway 4 per cent. Debenture Stock	112 0 0	88 10 0
	391 9 6	5 per cent. War Loan	398 18 7	402 5 0
			£25,410 6 0	24,945 12 10

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One-hundred-and-seventy-fifth Annual General Meeting, for the purpose of receiving the Council's Report and the Financial Statement for 1928, and for the election of Officers, will be held, in accordance with the Bye-laws, on Wednesday, June 26th, at 4 p.m.

(By Order of the Council),

GEORGE KENNETH MENZIES,
Secretary.

COUNCIL.

A meeting of the Council was held on Monday, June 10th. Present:— Sir George Sutton, Bt., in the Chair; Lord Askwith, K.C.B., K.C., D.C.L.; Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.; Captain Sir Arthur Clarke, K.B.E.; Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Mr. P. Morley Horder, F.S.A.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Col. The Master of Sempill; Mr. James Swinburne, F.R.S.; Mr. Carmichael Thomas, and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

The following candidates were duly elected Fellows of the Society:—

Baker, W. E., London.
Bannister, William, J.P., Croydon, Surrey.
Bilderbeck, George Leslie, New London, Conn., U.S.A.
Fyfe, John Herbert, Calcutta, India.
Herdman, Ellice Bernard, Suez, Egypt.
Jeffreys, Arthur Gerald, Port Arthur, Ontario, Canada.
Kark, Victor Sais, London.
Macfarlane, Athol Herridge, M.C., Hillah, Iraq
Mackenzie, John Fraser, Nairobi, Kenya.
Powell, Lange L., Brisbane, Australia.
Rhodes, Harold, A.R.C.A., Manchester.
Sakai, Yasudiro, Tokyo, Japan.
Sampson, Charles Victor, La Paz, Bolivia.
Sumner, John, Powyke, Worcester.
Taylor, H. Stanley, Bath.
Wilson, George Heron, East Grinstead, Sussex.
Wright, Reginald W. M., Bath.
Wood, Gladstone Stanley, Chesterfield.

The resignation of Sir Alfred Yarrow, Bt., F.R.S., was accepted with regret.
The terms of the award of the Albert Medal were settled [see page 784 below.]
The number of entries for the Competition of Industrial Designs was reported.

The Report of the Council for the session 1928-29 was considered and approved for submission to the Society at the Annual General Meeting.

A quantity of financial and formal business was transacted.

THE SOCIETY'S ALBERT MEDAL.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of the President, H.R.H. the Duke of Connaught, to Sir Alfred Ewing, K.C.B., LL.D., F.R.S., Principal and Vice-Chancellor of the University of Edinburgh, "for his work on magnetism and his services to Technical Education."

The medal was founded in 1863 as a memorial to Prince Albert, for eighteen years President of the Society, and is awarded each year "for distinguished merit in promoting Arts, Manufactures and Commerce."

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

WEDNESDAY, MAY 8TH, 1929.

PROFESSOR W. ROTHENSTEIN, M.A., Principal, Royal College of Art, in the Chair.

THE CHAIRMAN said he took it that the honour of presiding that evening had been conferred upon him largely because he had also had the honour—perhaps the greatest of all in his fairly long life—of having been an official artist during the war. It had certainly been an immense privilege for a non-combatant to go through some of the hardships of the men who had taken part in the actual fighting. He was looking forward with the greatest possible interest to hearing the lecture and to seeing the slides. If he might be allowed to say one thing for his own profession, it was the fact that for the first time, probably for 200 or 300 years, there was a subject matter in common between the artist and the public which made most of the war pictures the most significant pictures which had been produced in our own times. That was a state of things which everyone would like to see recur somehow, so that there would be that marvellous partnership again—a common subject matter which would allow people to follow works of art without thinking of the three dimensions, but sharing with the artist common human experience.

WAR AND ITS INFLUENCE ON THE ARTS.

By CHARLES FFOULKES, O.B.E., F.S.A.,

Curator of the Armouries, Tower of London.

The subject which I propose to discuss this evening has so many ramifications that I am compelled to deal only with one aspect and must perforce leave,

with regret, the influence of war upon architecture and the applied arts, the loss of priceless works of art by the destructive agency of war and the introduction of alien styles and fashions by conquerors who imported their own artists and imposed their will, political, economical and artistic upon vanquished nations.

Time also will not allow me to consider the war records of Assyria, Egypt, Greece and Rome, though each of these merits special study from which we might learn much of the military operations and equipment of past ages, a study which, in this country at any rate, has never received the attention which it certainly merits.

I shall confine myself this evening to the pictorial and sculptured military records from the thirteenth century up to the present day, and even here there is such a vast amount of important material worthy of consideration that I can only touch upon certain typical examples as illustrating the value of these records as illustrations of historical events.

The psychology of war, the reasons for its periodic outbreaks and the possibility of its prevention, must be left to abler students of the subject, but I am sure that all of us, with the exception of a few savage militarists, will agree that it is a terrible upheaval of society which must be avoided at all costs. At the same time, in considering the artistic development of the several nations of Europe we shall be obliged to admit that the history of art and craftsmanship is very definitely bound up with national history, and national history is the history of conquest and war.

Napoleon III, under whom those exhaustive studies on the history of artillery were produced, went still further, for he attributed the development of the whole of civilisation to artillery alone. Writing in 1872, after his own tragic experiences, he states, " L'histoire de l'Artillerie est l'histoire du progrès des sciences et partant de la civilization."

All pictorial and sculptured art from the eleventh century onwards was produced under the patronage of kings, princes and high ecclesiastics, and to these riches and wealth in the first instance were simply matters of land and territories, which were only acquired by conquest and were held only by strong military forces until such time as a stronger power arose and opposed them.

It therefore follows that it was only the conqueror or the ruling prince with a stabilized empire who could hold his own and establish a court as a centre of learning and of the arts, and could patronise the artist, sculptor and craftsman either by directly employing the lay artist or by founding monasteries and ecclesiastical establishments in which the miniaturist could work in safety, peace and quietness. Such great princes as the Medici, Francis I of France, King René of Anjou, Maximilian, Napoleon and the British government in the late War were conquerors, or at any rate held large possessions by force of arms, and it is to their patronage that we are indebted for many of the finest examples of the allied arts, and it is their military exploits which have inspired

artists to produce work which has its place in the history of art quite irrespective of its military value. It may be urged that some of the greatest works of art have been produced under the patronage of the merchant princes of Venice and the Netherlands, but these, I suggest, amassed their riches either by loans for war purposes or by trading, which could only be carried on in safety because it was protected by armed power on sea and on land. I only know of one instance where a beaten nation produced military works of outstanding merit. I refer to the military paintings of the War of 1870 by Edward Détaille, which as portrayals of actualities and at the same time records of military equipment, minute to the smallest detail by an eye witness who actually served in the French army, are unsurpassed.

Military paintings and representations may be broadly divided into three catagories :

(1) the religious, i.e., illustrations from the Old and New Testaments,

(2) fables, or romantic histories, such as " The Romance of Alexander," " The Life of Charlemagne " and,

(3) historical, as for example, " The illustrations of Cæsar's Gallic War " in the " Harleian Manuscripts," the illustrated " Froissart " also in the Harleian Manuscripts, " The life of Richard Beauchamp, Earl of Warwick," the Cowdray paintings, and many others, including all the military painters of the eighteenth, nineteenth and twentieth centuries.

Taking the religious subjects first. These as I have said are mostly illustrations from the Old and New Testaments, and it is in the Old Testament that we find innumerable miniatures depicting battles of Israelites. Here the Israelites are always shown as the victors, and the same may be noticed in the illustrations of fables and historical events up to the sixteenth century, where the armies of the hero, or of the nationality to which the painter or his patron belonged, are always portrayed in the best possible light. Up to the end of the sixteenth century the artist almost invariably depicts the fighting man in the costume of his own period, and herein is most valuable double-edged evidence, especially in illuminated manuscripts, for, if we know the date of the manuscript we can be certain that the armour portrayed is of that date, but if we do not know the date of the manuscript and from other sources we know the date of the armour that is represented we can date the manuscript with a considerable amount of accuracy.

The artist from the eleventh to the sixteenth century had no antiquarian knowledge whatever. It is true that Italian painters of the Renaissance, such as Mantegna and Guilio Romano, having the remains of Roman sculpture to guide them attempted to give some sort of historical accuracy when dealing with classical subjects, but for the most part the soldier, whether he be an Israelite or one of Charlemagne's paladins, or indeed Joan of Arc, was always equipped in the armour which the artist knew and had before his eyes.

I have noted the absence of historical data in most of the early battle pieces but there are other aspects which have never received the consideration which I think they deserve. One is that all battles from the Bayeux tapestry right up to the military prints of the earlier nineteenth century show the combatants at full speed, which when we consider the cumbrous equipment of the mail-clad knight of the thirteenth century or the heavily laden grenadier of the French Imperial Guards, must have been an absolute impossibility. Another interesting detail which I do not think has ever been seriously noticed is that in all these battle-fields the combatants are shown in full armour or uniform. Occasionally we have written records of fighting men discarding their armour in order to move more easily, as in the notable and off-quoted example from the chronicles of Du Guesclin, from which we learn that at the Battle of Mont Auray in 1364 Sir Hugh Calverly ordered his men to take off their cuisses or leg armour in order to move more easily; and again we have the instance of Sir Philip Sidney and Gustavus Adolphus being killed because they had discarded portions of their armour. Very seldom, even in later years, except in pictures by De Neuville, Détaille, Vereschagin and Lady Butler, do we find troops represented as travel-stained, unkempt and ragged. The artist of the late nineteenth century is more of a realist, but even here if we compare the finished painting with some of the sketches of war correspondents we find that there is still a portrayal of what, for want of a more polite expression, we may call the "spit and polish" beloved of the sergeant-major. The reason for this is threefold: firstly that the artist had to please his patron, who naturally desired an attractive record of his military operations, secondly with few exceptions the artist worked in his studio and had very little first-hand knowledge of the carnage of a battlefield, and thirdly, in the case of easel pictures or wall decorations he had to produce something which was inspiring and not terrifying to the public. The great military paintings at Versailles, the wall painting by Maclise in the Houses of Parliament, and such pictures as Philippoteaux's "Battle of Fontenoy" all show the soldier smartly equipped with no hint of the fact that he had been marching through miry roads and fields in a long and arduous campaign.

Such works of art may be, and indeed they are, valuable records of the actual uniform and equipment, but they are of little value as accurate portrayals of the fields of battle.

Another section of our subject which I propose to touch upon is the single figure, painted or sculptured, as a record of military equipment, and here we are still faced with glaring anachronisms. St. George, who is a favourite subject for military sculptors, is almost invariably represented in the armour of the period, for to the artist and sculptor he was a symbol of courage and not a historic personage.

Joan of Arc has probably caused more artists to sin in this direction than any other military saint. I have a collection of reproductions of St. Joan,

which range from a contemporary print up to the eighteenth century, and she is invariably depicted in the armour of the period in which the artist lived. Indeed, in the eighteenth century she is shown in a long skirt with breast and back plate and three-cornered hat. The modern artist with all the resources of antiquarian knowledge and research at his command is a terrible sinner. I know of one very popular modern representation of St. Joan in which she is dressed in what is known as " Maximilian " armour, which was in vogue during the first half of the sixteenth century.

In our own time, when the whole country is studded with War Memorials of varying merit, it has always seemed to me extraordinary that St. George in fifteenth-century armour should be so popular. The equipment of the British soldier in France and Flanders with steel helmet, gas-mask, putties and sometimes fur covered jerkin is as fine a subject for decorative art as could well be imagined, and if used to the fullest extent in sculpture would provide our descendants with an accurate record of the equipment of the earlier part of the twentieth century, as Can Grande at Verona and Colleone in Venice gives us the armour of the fourteenth and fifteenth centuries, but St. George in an English provincial market town means but little to the inhabitants except that it is part of the War Memorial, and to the student of arms and armour his equipment is often distressing in the extreme.

A further aspect of our subject which deserves notice is the inspiration of war and military subjects to the artist, and this inspiration may be under one or more aspects. There is composition of men in serried ranks, as, for example, Velasquez's " Surrender of Breda," or Charles Furse's great portrait of Lord Roberts where the crowd of vertical lances gave a form of composition which could not possibly have been obtained in a peaceable subject. There is the disordered confusion of fighting men which could not be found in peacetime. There is the gorgeous colour of plumes, surcoats and standards, as in the painting of " The Battle of San Romano " by Uccello, and of course the brilliant uniforms in the paintings of the late eighteenth and early nineteenth centuries, and there is also the excuse for displaying the artist's knowledge of human anatomy in violent action.

In later years we find occasionally an endeavour to show what a terrible and bestial method of settling international disputes war is, and always must be. The etchings of Callot and Goya, though not actually depicting fighting, show the futilities and horrors of war with powerful realism, which has never been equalled, but with such terrible detail that it is inadvisable to show them as illustrations.

War paintings have been, and always will be to a large extent propaganda for the glorification of the victor and of the fighting man, but with the exception of Goya and Vereschagin we hardly ever find the real terrors of war depicted, even by competent artists of high reputation. In the great wall painting of the meeting of Wellington and Blucher by Maclise the whole of the foreground

is crammed with dead and dying, all in conventional attitudes, and with very little suggestion that they have passed through a strenuous campaign and hard fought battle, but the detail of uniform, weapon and equipment is meticulous and most valuable. It is not until we reach the middle of the nineteenth century that we find war treated with pathos, as in "The Roll Call" by Lady Butler, which in no way revolts the beholder, but simply appeals to one's sympathy.

In 1917 a powerful Committee under the British government evolved a scheme for using the work of living artists for propaganda purposes. These artists in many cases were serving in either the Navy, Army or Air Force, and they were given the choice to continue serving or to produce records of the war on all fronts which would automatically become the property of the State. The choice of artists was Catholic in the extreme; practically every school of painting was represented and as a result the Government possesses examples of the work of most of the principal painters, etchers and of a few sculptors which illustrating British art during the period of three years, is unequalled anywhere else in the world. These works of art were originally intended as propaganda to arouse the interest and enthusiasm of those at home and to attract the sympathy of neutral and allied countries, but it was very soon seen that the propaganda was of a very different nature to what might have been expected. The sole condition of the employment of the artist was that he must have seen, and possibly experienced, the subjects which he portrayed.

When we examine the subjects of the ordinary peacetime picture Exhibition—the landscapes, the peasants, the bathing ladies and the fashionable portraits, it is not surprising to find that these artists accepted with enthusiasm the commission of the Government. Here they were faced with entirely new conditions such as could never have been dreamed of before: curious effects of atmosphere, strange problems of perspective and men in unnatural attitudes, living, working and fighting in unnatural surroundings. The result of this was that the artist found himself as he had never found himself before, and will never find himself again. There was no need to rack the brains for composition or for a subject. It was there at every moment and at every turn of the road, the only difficulty was to make the choice, with the result that this great collection of pictures is unsurpassed in any nation, or at any period in the whole history of art.

I propose to divide my illustrations into groups illustrating the treatment of the subject rather than into the historical periods which I noticed at the beginning of this lecture. These groups may be broadly classed as :—

(1) *The ignorant anachronist,* under which heading we shall find the miniaturists and sculptors of the thirteenth, fourteenth and fifteenth centuries, who had no antiquarian knowledge of costume or armour of any period previous to their own.

(2) *The wilful anachronist,* that is, the artist who lived in more modern

times and could, if he had taken the trouble to make some researches, have costumed his fighting men with historical accuracy.

(3) *The pseudo realist.* By pseudo realist I mean the man who took meticulous pains to get every button, strap and sword hilt correct and yet gives one only the impression of a number of studio models posed in theatrical attitudes, but with no hint whatever that his figures are fighting desperately for their lives.

(4) *The contemporary recorder,* that is the artist who recorded what appear to be actual war conditions but of whom we have no evidence as to whether he was an eye witness.

(5) *The eye witness,* the man who saw and knew, and who had experienced the things which he was depicting.

Under this last heading it may possibly be urged that the most realistic representation of war, or in fact any operation of life, is the photograph, but there are serious objections to this. In the early days of Press photography we were satisfied that the man with the camera was on the spot, and it used to be a byword that the camera could not lie, but in more recent years, with more experience and with some of the astonishing composite photographs which appear in the Press before us, we can only be convinced that Ananias was a mere tyro when compared with the highly skilled expert photographer if the photograph, as taken, does not suit his purpose. Another objection to the photograph, particularly in treating war subjects, is that the photographer is obliged to take what he can see from his position, quite irrespective of where the sun is, what the weather conditions are and what the nature or colour of the ground may be which he photographs. The result is that very often the most important detail of his picture is lost and can never be recovered, but with the trained military artist he sees exactly what he wants to record, jots it down in a few lines and eliminates all the non-essentials.

I will now proceed to put before you my illustrations and again I must warn you that these are not chosen for their artistic value, but are shown solely as records of war operations and equipment as treated by European artists and sculptors of the last 500 or 600 years.

Under the heading of the anachronist we must in all fairness admit that there was no antiquarian knowledge or interest in the thirteenth century and the object of all religious painters was to make the Old and New Testaments alive and real to the people. The examples of this type are a battle between the Israelites and Philistines from the magnificent thirteenth century manuscript in the possession of Mr. Pierpont Morgan which shows the Israelites in full mail equipment of the period but gives the Philistines, as Gentiles, the somewhat out of date armour of the eleventh and twelfth centuries. This engraving by Deutsch about 1540 depicts the battle of Sempach fought in 1386. It is, therefore, useless as a record of the battle, but is of great interest as a rare portrayal of first aid and medical services in the field. The beautiful Easter

Sepulchre in Lincoln Cathedral shows armour also of the early fourteenth century. With regard to single military figures we have the St. George of Dijon, middle of fourteenth century, St. George of Prague, late fourteenth century, and Pisanello's St. George in the National Gallery, middle of fifteenth century, all of no value whatever as records of the possibly mythical St. George, but all most useful as examples of military equipment. The woodcut of St. Joan from "La Mer des Histoires" produced about forty years after her death shows a type of armour which was not in vogue at the period of Joan of Arc's military career.

We next examine the Wilful Anachronists, that is those to whom historical records were available but who from pure carelessness preferred to trust to their own imagination or to their incorrect ideas of history. Here we have a scene from the Siege of Troy by Giulio Romano in which the Greeks and Trojans are wearing Roman armour, and that too of the late Roman Empire as shown on the Trajan Column. Next is a picture by David of the Rape of the Sabines in which the combatants are in Greek armour, all very smooth and clean with no hint of the turmoil of battle, and studied more as an exercise in composition, for the lady in the foreground has obviously been introduced to bring the two parts of the composition together. In our own time Boydell, artist and Lord Mayor of London, produced great historical "tableaux" as they were called which even now are used to illustrate history books and works of reference. In his version of Scene 5 Act II of the 3rd part of Shakespeare's Henry VI, the armour shown is of the seventeenth century and bad at that, the helmet of the King being of a type in vogue in Spain two hundred years later than the death of Henry. We will turn for a moment to St. Joan of whom throughout the ages there are thousands of representations about 75 per cent. of which are entirely misleading. A seventeenth century print shows the Maid in Roman armour, and in one of the eighteenth century she is modestly dressed in long skirt with sixteenth century sleeves, and lastly Sir John Millais, who ought to have known better, gave us St. Joan in fluted Maximilian armour which was introduced just about a hundred years after her death.

The last instance of wilful anachronism which I will mention is the very beautiful illuminated copy of Cardinal Mercier's pastoral letter, produced by the Nuns of Maredret. Now the devoted artist must have made minute researches to get the thirteenth century equipment, with which she has armed the British Expeditionary Force correct, but if she had just looked out of her window she would have seen that the present day helmet, gas mask and putties are decoratively as fine as any armour of the past and this work would have been of great historic value instead of being merely a fine example of modern illumination combined with some unconscious and unintentional humour.

Now we have the Pseudo Realist, that is the artist who has taken pains with his detail but has in most cases entirely missed the reality of war and only

suggests studio composition or at best a theatrical pageant. Philippoteaux's Fontenoy, 1745, though meticulously correct as to uniform and arms is more suggestive of a parade or inspection than of a battle. England had been fighting in Europe since 1743, so that it is hardly likely that both English and French troops would have arrived at Fontenoy in new uniforms. The same artist produced a great panorama of Waterloo. This is more realistic, but he cannot get away from the traditional convention of battle pieces. Still it is probably as near to the original as it is possible to get, but we should note that the old black powder used at Waterloo would have created such a smoke that the scene which the artist depicts could never have been visible for a moment. Heath's numerous battle pieces have no pretensions as works of art, but they do show, considerably compressed, the dispositions of troops. Maclise in his great wall painting in the houses of Parliament is frankly concerned with the filling up of a certain space with a given subject. He shows heaps of dead and dying men with no suggestion of the horror and misery of a battle-field, each figure is nicely posed and most of the faces bear an expression of sorrow or boredom rather than of agony and pain.

The Contemporary Recorders as I will call them are those who depict the battles of their own time with probably some accuracy but the conventions of art precluded them from any suggestion of realism as we know it to-day. From the Cottonian MSS. in the British Museum we have a drawing of the Siege of Caen in 1418 by the Duke of Clarence and Richard Beauchamp, Earl of Warwick, but even here we must be cautious for the manuscript was produced about the year 1480 and the armour is more of the style of the late than of the early fifteenth century. Still the artillery, ship, shields, etc., can be taken as useful records of the period. The next three illustrations are from German engravings. A sixteenth century print shows a siege of the period and Amman's print of an army on the march must, I assume, have some relation to fact, though one cannot help wondering what would happen to these troops in close array if they were suddenly surprised or ambushed. The two next pictures are from the paintings in Cowdray Castle which were destroyed by fire in 1793. They represent the Siege of Boulogne in 1544 and were produced for Sir Anthony Browne, the owner of Cowdray who with his retinue is shown on one of the paintings. They can therefore be considered accurate and contemporary records of great value. This fine drawing by Durer is exhibited to show what was probably the fighting equipment of the knight who probably discarded leg armour and horse armour when engaged in extended campaigns.

The work of actual eye witnesses shows us that to-day at any rate the battle is so widespread that, except in attacks which as a rule the artist does not see or if he does is so strenuously engaged that he can take no notes, artillery fire at long range dominates everything, and the incidents, except those behind the line, must be left to the imagination. I give this illustration of a chest at

New College representing the Battle of Courtrai in 1302, because from internal evidence I feel convinced that the sculptor was present as a combatant. He places the Guild Banner of the Carpenters first when that of the Masons should have occupied that position and the fact that the only surcoats emblazoned are those of the men of Ypres held in reserve at the Castle suggests that he was a member of the Ypres Guild of Carpenters. All the French heraldry which the reserves would not see is wrong, but the banners of the French governor of the Castle where the reserves were posted are correct. I take leave, therefore, to rank this carver of Ypres as one of the earliest war correspondents. I show two illustrations of Vereschagin. He was with the Russian forces in Turkestan in 1867, in the Russo-Turkish war of 1877 and was killed on the Russian flagship in the Russo-Japanese war of 1904. The first shows an engagement in 1867 and the second is one of his powerful works illustrating the aftermath of battle. Goya and Callot have both treated this aspect of our subject, but as I have stated previously their illustrations are so terribly realistic that it would be inadvisable to show them before this society. I will now put before you the work of the artists commissioned by the Ministry of Information and the Imperial War Museum during the late war. There was one condition only made, that the artist must have actually seen the incident he portrayed and I feel sure that you will agree that each artist working in his own style with his own methods and ideals has produced historical records of the greatest value and also, if I may venture to express an opinion has added considerably to the honour and reputation of British art. The works are "The Harvest of Battle" by Mr. Nevinson, the "Attack at Dawn" by Mr. Williamson, who I believe figures in the painting, "An Advanced Dressing Station" by Professor Tonks, "The Somme" by Mr. Muirhead Bone, the "Ypres Salient" by Mr. Paul Nash, a Howitzer battery by Sir William Orpen, "The Battery shelled" by Mr. Wyndham Lewis and the historic "Entry into Jerusalem" by Mr. McBey. The last of this series are sketches actually made on the spot, but the artists' names are unknown as they have been cut out by the censor during the war period. The first of these is the tank attack at Cambrai on 30th November, 1917. Here you will see that the artist has only recorded the essential details, a selection which the photographer cannot make. I only show the photograph in the next illustration to emphasise this for the lens of the camera could not record in detail what the eye might see quite clearly. In the last illustration you will see how the sketch made on the spot is translated for home consumption. No essential factors are missing, no details are altered and yet the old tradition of the battle piece still survives, presumably because the public expects it. I have endeavoured to put before you representations of War by all Schools, solely to show how these are of value or the reverse as illustrating military operations.

What have we learned from these illustrations, and of what value are they to the historical student of military affairs? In the first place they are of

the utmost value as records of the equipment of the fighting man of all ages, but at the same time they are of little or no value as actual records from which the battles which they purport to represent can be reconstructed. Even in the fourteenth century, battle was a widespread engagement and could seldom be adequately represented as a whole, and in the nineteenth century, though some attempt was made to give correct disposition of troops in Wellington's battles, the limitations of the picture forced the artist to crowd his armies together in such a manner that both armies ought to have been all annihilated at once. Thirdly, in our own time we find that these war pictures are of value, of serious and of important value for incidents but never for battles and at the same time are careful records of the varied and mostly unauthorised equipment with which men fought under entirely unexpected conditions.

Much is being done in our schools to make history more alive and real, and illustrations in books and on wall sheets are employed in great profusion, especially in encyclopædias and works of reference. We may well ask ourselves, therefore, how far these are of value as correct representations of war operations or, indeed, of any events of history. The artist of the present day seems to be content if he shows correct costume and armour, but he neglects to study other details which, in my opinion, are of equal importance. He should investigate the weather conditions prevailing on each occasion, the position of the sun, the formation and actual soil-colour of the ground, the vegetation, the architecture of buildings, all details of equal importance to that of costume. All this needs research, but then no historical painting should be projected till minute and careful research has been exercised. There is, in this country, no excuse whatever for ignorance, for we have in the British Museum, in the Victoria and Albert Museum, and in the Royal United Services Museum, to say nothing of the thousands of war records in the Imperial War Museum, such a mass of contemporary records, both illustrative and descriptive, and all easily accessible to any one that it should be possible to recreate historical illustrations which would emerge triumphantly from the most expert criticism.

There is only one aspect which I have omitted, and that is the idealism which comes from the study of great tragedies and great suffering, and with the stupendous record of suffering and tragedy by the late John Sargent we will take leave of our subject, and we may well ask ourselves of what value to humanity is this unending record of triumph, racial emnity, cruelty and death. Mercifully this aspect of war grows less and less as the years roll on, for time softens tragedy, but what remains is what I hope and believe is the inspiration of most of the best of these battle records—the courage, the sacrifice, the patriotism and the national pride, and these attributes must always be a valued possession and splendid tradition to hand down.

In former days to those at home war was a glorious pageant and but little of its horrors was realised by those who cheered the troops going out to fight and welcomed them after their victory, but to-day war is and will be nearer to us

who, even at what is known as the "home front," in the late war had bitter experience and could realise, but in a far lesser degree, what our kinsmen were enduring overseas. Our contemporary artists, as I have shown you, were not stay-at-home men comfortably working in studios, with only an occasional air raid to disturb their equanimity. They were men who bore the heat and burden of the day, who endured the discomforts and dangers of the fighting men, and all of them gallantly performed the duties allotted to them, some winning well deserved honour in the field. These were not the men to produce highly coloured works for propaganda purposes, in which well equipped troops with colours flying defeated the panic stricken enemy. They knew too well the grim horror and had themselves walked through the "Valley of the Shadow" and if any work of art can be deterrent the records of these British artists should be valuable assets in educating the world to peace. As long as there are great tragedies in history which call for courage and endurance these subjects will always appeal to the true artist, but in the future they must be treated with knowledge, skill and respect and will illustrate and explain history, making it real and living, not merely the pageant of a by-gone age.

DISCUSSION.

THE CHAIRMAN said the lecturer had made one thing perfectly clear, namely, that war in the past had been a kind of craft or mystery which a comparatively few professional men understood, but that to-day it was something in which the whole nation was engaged and the tragedy of which was shared by all. He thought the last slides which had been shown proved that fact—that men who had made records had done so from the profoundest human point of view, and not from the point of view of showing what was, after all, the false glory of war. He only regretted one thing—that the lecturer had not shown one or two of Goya's pictures, because the difference between Goya's etchings and other people's was that Goya had seen his own country invaded and his indignation had allowed him as an onlooker to do what no other artist had ever dared to do. Goya's pictures had not been known in his lifetime; they had not been discovered until after his death. If anybody wanted to see the most passionate expression against the horrors of war he recommended that they should go to the Print Room of the British Museum and look at Goya's "Disasters of War."

SIR MARTIN CONWAY said that Mr. ffoulkes and himself were in charge of the War Museum. Technically he himself was in charge of it, but practically Mr. ffoulkes was in charge, and all the credit for its arrangements and the work which had been done in it were due to Mr. ffoulkes and not to himself. But together they took an immense interest in that institution, and especially in the collection of paintings, drawings and prints of all kinds which were there housed. In a certain sense it was one of the most important collections of works of art in the world. It was entirely unique, and probably would remain so for all time, in that it represented not merely deeds of persons who had taken part in the Great War, but the mood of the country, and the mood of the fighting forces. The artists had naturally reflected the mood of the masses which had surrounded them. From different points of view each artist had approached his subject, and his mood had

emerged. In old war paintings one never found anything of the reflection of the mood of the people; those old paintings and prints were more or less mechanical reconstructions of actual fact. The pictures in the War Museum, on the other hand, made no pretence at all to represent actual fact, but represented the mood of the men, suffering month after month and year after year, and the terrible trials which had been imposed upon all the fighting forces and, to a less degree, upon the people at home. It was that fact which made the collection of works of art in the War Museum unique and of such enormous value—a value which would increase as the years went by, because they would show to future generations the spiritual condition of a great country when submitted to a great trial. Those who had not yet visited the Gallery at South Kensington had moments of great instruction in store for them.

The lecturer had shown a very interesting historical collection of illustrations of war. Looking through ancient manuscripts depicting acts of war, it was extraordinary how little warlike knowledge the artists had. It did not matter whether it was a battle between the Israelites and the Philistines, or whether it was the Siege of Troy or Alexandria, or whatever it was, in all of them there was the same kind of merely decorative treatment of the subject suitable for the embellishment of a page, or suitable merely to illustrate the text—which they did not illustrate but which they merely adorned. The British Museum had many such manuscripts. They were usually very inefficient as illustrations of war, although they possessed the highest merit as decorative adjuncts of a book.

The lecture illustrated Mr. ffoulkes's vast knowledge of the subject, and he was sure the audience would desire to pass a most hearty vote of thanks to Mr. ffoulkes for his most interesting lecture.

The vote of thanks was carried unanimously.

Mr. Ffoulkes, in acknowledging the vote, said he did desire to impress upon students that it was really important to study these matters at the fountain head. There were records in the museums of this country which could not be equalled in any other country in Europe. It was simply a matter of writing for a ticket. The whole of the history of the subject would then be open to any student. There was, therefore, no excuse for any historical inaccuracy when such splendid records were available, of which he hoped all students would make use.

The meeting then terminated.

NOTES ON BOOKS.

The New Interior Decoration. By D. Todd and R. Mortimer. London: B. T. Batsford, Ltd. 21s.

An excellent book; written with knowledge and style, well illustrated, well printed, not expensive at the price. The authors have a thesis: they have stated it succinctly. Their preliminary essay is comprehensive, and is important both as description and criticism. Interior decoration is a matter of industry as well as art, and therefore the concern of manufacturers and the public as well as of a handful of painters and dilettanti.

There is, Mr. Mortimer and Miss Todd assert, such a thing as twentieth-century "period," and whereas it is incongruous and unsatisfactory for modern people

to live and conduct their lives and businesses in *other* "period" surroundings, it is natural and right for them to sleep in bedrooms and work in studies that are one in spirit with motors, liners, aeroplanes. Le Corbusier, the Swiss architect and decorator, has said that a house must be regarded as "a machine for living in." Like him, the authors are enthusiasts for ferro-concrete, long horizontal windows, the abolition of mouldings and the frank exposure of fittings. Their photographic illustrations show exteriors and interiors by Le Corbusier, Bourgeois, Stam, Oud, Gropius, Neutra and others; and certainly, if it is right to live in accordance with a particular interpretation of the spirit of the present age, let those who can afford it get one of these architects to design their homes.

Before criticising this point of view it may be a good thing to mention that there is a very sensible bass accompaniment to the blithe treble trillings of Mr. Mortimer and Miss Todd. For they explain that it is the need for compromising between the shapes and adjuncts of old houses on the one hand, and the demands of modernity on the other hand, that has mothered the decorative art of Duncan Grant whom they regard as a great painter; indeed, a great master. Duncan Grant is a great painter, and his modern decoration is great decoration. Le Corbusier is a brilliant, enterprising architect and decorator: he is original and interesting, and so is his work: but are he and it *great*?

The half-hearted revivals of the nineteenth century are condemned by the authors very properly. Alone, we read, the skyscraper and the Eiffel Tower stand as signs of grace in that disgraceful age. But the authors themselves confess to disappointment in the American skyscraper, which has mostly been spoilt by touches of Gothic and Renaissance character Now this is not the only fault of the skyscraper, and its monstrosity is the only virtue of the Eiffel Tower.

The best building of the Middle Ages was too supernaturally inclined to let it rank with the best work of Greece, Rome and the Italian Renaissance. very human architecture and decoration. It looks as if the most forceful architecture and decorative art of the first half of the twentieth century is too much aiming, not at the supernatural, but at the superhuman, to be of the highest order. For the superhuman has almost everything in common with the subhuman. How uncomfortable sensitive, untidy people must feel in rooms where the most priggish qualities of metal and enamel are coldly and perfectly expressed, as in a design by Le Corbusier! The continuous reproaches of immaculate linos must be more distressing than the dust-collecting proclivities of a nice, thick, old-fashioned rug.

There are *two* New Interior Decorations. Both are important, but the more striking is the less so. The more striking, though more extreme, is not more ingenious or more thorough. On the other hand, Duncan Grant, like the great artists of the Renaissance, will refrain from no device however old-fashioned that he thinks will contribute to the effects he wants to produce He is creative, and so more than a talented eclectic. In a quiet way he is Twentieth Century "period," even if at first sight one fancies that his mission is the annihilation of period. At any rate, his work is very human, in some respects the absolute antithesis of Le Corbusier. For instance, it is often done in what looks like an almost clownishly slipshod, patchy, opportunistic way: herein it is the opposite of mechanical. The best decorations for a Le Corbusier wall are abstract designs. Grant puts form before everything, but not form dissociated from all human habits and interests.

From the fact that the two schools admire one another it is fair to conclude that they have something in common; but is seems to me, none the less, that their paths are more likely to diverge than to unite, as Mr. Mortimer and Miss Todd prophecy they will do.

But the Continental mechanistic movement must not be underrated. It is sane, healthy and economical; the doubt is as to its beauty. The concluding chapter, on "Methods and Features," is of practical value. Our houses in England have a long way to go, so to speak, before they run any danger of being accused of extremism.

P. B.

TUNGSTEN; A TREATISE ON ITS METALLURGY, PROPERTIES AND APPLICATIONS. By Colin J. Smithells. London: Chapman & Hall, Ltd. 21*s*. net.

Metallic tungsten of a century ago was a semi-fused hard granular product obtained by reducing an oxide with charcoal at a forge or wind-furnace heat, and chemical text-books of this period usually dismiss the subject of tungsten in a few lines, terminating with some such sentiment as "no industrial applications." Some rather important industrial uses were made of the carboniferous tungsten as also of the compounds during the second half of the nineteenth century, and we may mention magnet steels, and high speed or self-hardening steels, but it was nearly the end of the nineteenth century when physicists began to realise that the true tungsten ranges close to carbon as to infusibility; the old tungsten being a highly carbonised product comparable with cast iron and owing its greater fusibility to the presence of impurities, chiefly the carbon. It was also realised that if lamp-filaments of nearly pure tungsten could be satisfactorily made and successfully used, electric lighting by the incandescent lamp could be put on quite a new basis of efficiency.

In the volume before us, Dr. Smithells gives vivid pictures of the quest for an industrially practical method of making useful filaments of tungsten, and from a theoretical or instructional standpoint we may touch on the method described at the end of p. 6:—(1) Carbon filament being under electric control for heating; when in an atmosphere of hydrogen and tungsten hexachloride it becomes coated with metallic tungsten; (2) At higher temperatures in atmosphere of hydrogen, the carbon and tungsten unite forming a carbide, (3) Heating in atmosphere of hydrogen and water vapour: result a hollow or tubular filament of pure tungsten. Practice has found this system of making a kind of tungsten pseudomorph of the carbon film to be rather expensive, and has drifted towards methods in which plastic materials are squirted through a die, all but the tungsten being subsequently eliminated by suitable treatment. The plastic mixture may be an amalgam-like paste of tungsten, or an aqueous paste of colloidial tungsten (p. 7), but dextrine or starch may be used to make a paste with water and finely divided tungsten (p. 6 and *cf.* p. 40 as to particle size).

This Volume of VIII + 168 large octavo pages, with 156 illustrations, some as inset plates, and a good index, carries the above suggested methods from the filament to the ingot (p. 46), and from the ingot to the faggoting and swaging machines (p. 47). Next we are led to the wire-drawing machines for pure tungsten, (p. 49), and thence to *pp*. 143-144, where we read of copper-tungsten wires, which may be adjusted in composition for sealing into any kind of glass.

We heartily congratulate Dr. Smithells on his thorough and satisfactory text-book on tungsten, which chiefly emphasises the new work of the present century; but the earlier work from the illustrious Scheele (1781), to the filament era is sufficiently considered, and suggestions for the future are numerous and pertinent. Hence it is that every chemist, every electrician, and every metal-worker should possess a copy for reference.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, 17TH APRIL, 1929.

PROFESSOR LEONARD ERSKINE HILL, M.B., F.R.S., Director of the Department of Applied Physiology, Medical Research Council, in the Chair.

The following paper was read:

THE PROPERTIES AND APPLICATIONS OF "VITA" GLASS.

By F. E. LAMPLOUGH, M.A.,
Late Fellow of Trinity College, Cambridge.

Glass is perhaps the most essential of all building materials. During hundreds of years it has been used universally for windows to admit light and keep out wind and weather, and in such climates as ours has therefore been almost vital to the development of civilisation.

Until the last few years all efforts in the manufacture of ordinary window glass have been devoted to the production at the least possible cost of large sheets without flaw or blemish, free from visible colour, and resistant to the weather. In the middle ages it was only possible to obtain pieces of glass a few square inches in area, of a greenish colour and full of defects which distorted vision; now, however, it is possible to produce sheets hundreds of times larger in area, almost colourless, of perfect surface and free from visible defect.

Whilst different compositions of glass have been developed for the manufacture of coloured glass for ornamental purposes, glass of great brilliancy

for table ware, glass with special chemical and physical resistance for laboratory workers and illuminating engineers, and glasses of very varied compositions to meet the exacting demands of optical instrument makers, the composition of window glass has only been varied in order to make its visible properties as perfect as possible.

Modern medical research has, however, brought to light a very important defect of ordinary glass from the health standpoint for it has been proved to be opaque to the most beneficial rays of the sun. In order to remedy this fault the lecturer made investigations in 1924 with the object of producing a new window glass having special transparency to the health-giving ultra-violet rays.

The scientific research involved was carried out with much encouragement from Professor Leonard Hill, and also from the authorities of the London Zoological Gardens, Dr. Saleeby and others and early in 1925 the first full scale melting was made of window glass (designated "Vita") pervious to the health rays.

In order to describe more fully the special property of the glass it is necessary to touch on the physical aspect of the position. Heat, light and sound are effects which are observable at a distance from the source of energy, this energy being conveyed by wave motion in an intervening medium, and the wave-length determines the nature of the energy. Thus when air is pulsating with a wave-length of a few feet the ear can be in tune and give the sensation of sound, the pitch of the note being determined by the wave-length.

In the case of light, however, we are dealing with waves in the medium which also conveys X-rays, ultra-violet and infra-red radiations and the electrical vibrations which are used as "carriers" in wireless telephony and telegraphy all travelling with the same velocity, 186,000 miles per second.

Wireless broadcasting stations use giant waves of hundreds of metres from crest to crest, but the wave-lengths of visible light are very minute and the tiny ripples of green light have a wave-length of but one fifty-thousandth of an inch or thereabouts. Expressed in terms of the usual "Angstrom Unit" (one ten-millionth of a millimetre), green light would be said to have a wave length of about 5,000 A.U.

To detect wireless waves more or less elaborate apparatus is necessary which may be tuned to unison with these waves and so absorb them. Our eyes can, however, tune to the tiny ripples of about the dimensions indicated and so detect them by giving us the sensation of light.

Newton demonstrated by the use of a prism the splitting up of white light into a band of colours, or spectrum, varying from violet to red. The extreme red waves have a wave-length of about 7,000 and the extreme violet 3,900, and the eye is sensitive to all intermediate wave-lengths and distinguishes them by colour discrimination.

Beyond each end of the visible spectrum range of colours there are in the

radiation from the sun rays which can only be detected by means other than sight.

The rays beyond the red, *i.e.*, the infra-red rays give the sensation of and are usually detected and measured by their thermal effects. Beyond the violet end the rays have very slight heating power and are frequently detected by photography.

A body heated to 500°C. emits radiation entirely in the infra-red. At higher temperatures the body begins to glow and its radiation comes within the red end of the spectrum so that the body appears red hot. As the temperature is raised the radiation shifts more and more toward the violet end of the spectrum as the glow becomes more yellow and eventually a white heat is reached. Some stars, still hotter than the sun, are at an intense bluish heat.

The sun's radiation corresponds to that of a body incandescent at about 6,000°C., and its maximum intensity is in the visible spectrum, the strength falling off in the infra-red, and rapidly in the ultra-violet region.

Ultra-violet rays of very short wave-length are harmful to the eyes and skin, but we are protected from these by the atmosphere, particularly by the ozone in the upper layers, and the limit of the ultra violet rays which reach the earth's surface is rarely below wave-length 3,000

It is now generally recognised that the radiation which has special biological value extends from wave-length about 3,200 A U. downwards. It will therefore be seen that the beneficial *natural* ultra-violet rays which we experience in our climate are for the most part included in the wave-length range from 3,000 to 3,200 A.U.

Ordinary glass is practically opaque to rays below 3,300 and therefore obstructs the beneficial rays. The new glass transmits radiation well below wave-length 3,000.

Fig. 1 shows diagramatically the splitting of a beam of sunlight by a prism and indicates how the beneficial rays are transmitted by a sheet of the new glass, but are obstructed when they meet a sheet of ordinary glass.

In Fig. 2 the actual spectrum photograph is given showing that "Vita" glass transmits the health rays which are obstructed by ordinary glass.

In the photograph the range from 2,900 to 3,100 has been marked as comprising the beneficial rays, but the range from 3,000 to 3,200 would be more correct. For the purpose of the photographic test an iron arc has been used to produce the ultra-violet radiation

The permeability of the new glass to the "vital" rays which are so valuable to life may be shown in various other ways. These rays cause sunburn and pigmentation or bronzing of the skin, and the effect frequently is nearly as marked when Vita glass is used to screen the sun as without the screen. Ordinary glass, unless very thin, practically prevents this action.

The fading of a special blue dye has been used by Professor Leonard Hill to measure the amount of valuable rays transmitted by the glass, and has

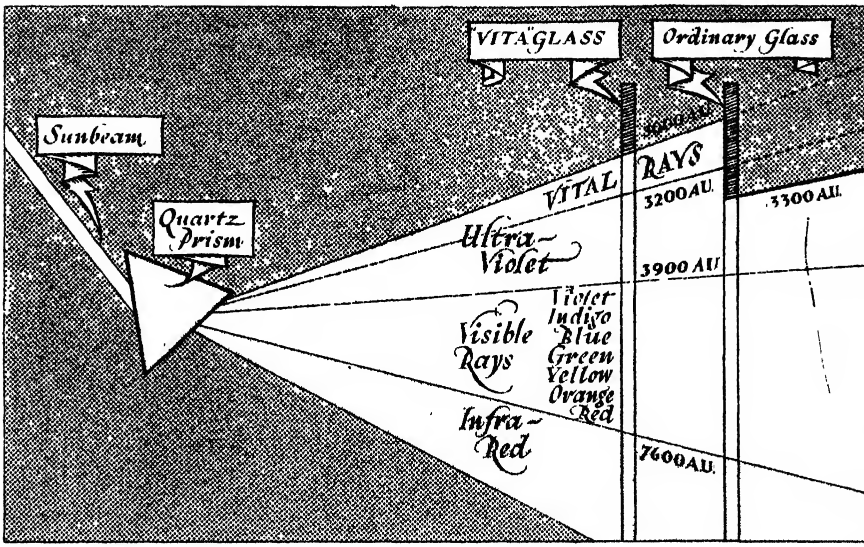

FIG. 1.

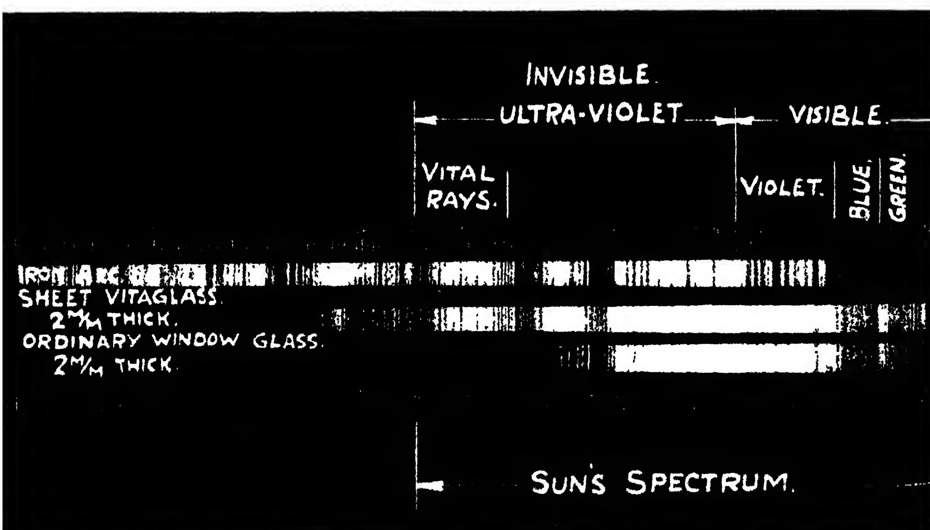

FIG 2.

shown that certain small organisms– infusoria · are killed by these rays after passage through "Vita" glass, but are completely protected by ordinary glass.

The best visible demonstration is given by the use of fluorescent substances such as uranium glass, or various dyes, which have the property of glowing

in ultra-violet rays. In making the experiment the beam from a mercur vapour lamp is filtered by a film of silver deposited on quartz or thin " Vita glass, so that rays chiefly of wave-length 3,1 isolated and produce the fluorescence The interposition of a sheet of " Vita " glass only slightly reduces this effect, but a sheet of ordinary glass practically extinguishes it. A photographic printing test may also be used with the same arrangement.

In ancient Egypt the sun-god Ammon ra was paramount. The Greeks practised heliotherapy. Roman villas were in many cases equipped with solaria or sun rooms, and a face well bronzed by the sun has always been associated with an appearance of health. It was not, however, till the last decade of the nineteenth century that the earliest careful scientific work was carried out by Finsen on the use of sunlight as a healing agent, and on the artificial production of radiation of similar properties Finsen soon realised that ordinary glass destroyed the special therapeutic property of the rays, and in his apparatus he made use of lenses of quartz which freely transmits ultra-violet radiation.

The first two or three years of the present century saw the establishment of a sun clinic by Dr Bernhard at St Moritz, in the Alps, where patients lay exposed without clothing to the outside sunlight The value of this pioneer work was at once recognised by Dr. Rollier, who in 1903 set up at Leysin the first of the famous establishments which have made his name well known throughout the world, and played a considerable part in establishing the importance of outdoor sunlight in the cure of various forms of surgical tuberculosis and other diseases. Similar work has also been carried out in this country with great success by Sir Henry Gauvain and other workers.

The use of ultra violet rays in the prevention and cure of disease forms a new branch of medical science to which attention has been given throughout the world, and the importance of these rays in furthering the general health and well being of mankind is practically universally recognised.

Whilst intensive bare body treatment is necessary to effect the cure of serious diseases, comparatively short exposures of small areas of the surface of the body are sufficient to have valuable effects.

Rickets and surgical tuberculosis are two of the most important diseases for which exposure to the sunlight is the best possible remedy Imperfect bone formation in children which characterises the very wide spread disease of rickets is due to unsuitable food and lack of the sunlight, which gives the body power to absorb the bone-building elements calcium and phosphorus. From tests in Manchester Dr. Leonard Hill states that " even the small amount of light in a smoky city suffices for the clothed child if out of doors all day."

If food is deficient in vitamin D, sunlight will make good this deficiency by producing this vitamin in the surface layers of the skin. It has, however, been amply proved that ordinary window glass removes from sunlight the rays which have this preventive or anti-rachitic effect.

Shortly after the introduction of the "new" glass it was proved experimentally by Dr. Leonard Hill in the case of mice fed on diet deficient in vitamin D that the glass allowed the passage of the rays from a mercury vapour lamp which prevented rickets, whilst ordinary glass obstructed the beneficial rays.

In America careful tests were carried out at Boston in January and early February, 1927, by the Council of Physical Therapy of the American Medical Association. In this research different groups of young chicks fed on defective diet were kept in separate compartments facing south and received light as follows:

(1) Sunlight through ordinary glass.
(2) Diffuse light of laboratory through ordinary glass.
(3) Sunlight through "Vita" glass.

The chicks were weighed at the commencement, 21 days after hatching, and at intervals throughout the test, the development of "leg weakness" being shown by appearance and by X-ray diagnosis.

It was found that all the chicks of groups (1) and (2) developed rickets, and after 40 days the weight had increased 2.30 and 2.43 times respectively. In other words, so completely were the anti-rachitic rays excluded by the ordinary glass that bright sunlight received through it was just as ineffective in preventing rickets as the weak diffused light of the laboratory.

On the other hand, out of 14 chicks of group (3) only two showed any trace of rickets, and the weight increase was more than double that of the other groups.

The results of the above experiment, carried out in *winter*, have been widely confirmed by the experiences of poultry farmers in the use of the glass. Similar tests have been carried out in the case of rats exposed to light from the north sky through ordinary glass and through the special glass, and these have proved the presence of the anti-rachitic rays in the light from the north sky.

In Kashmir the Purdah system is the cause of a bone disease akin to rickets From the age of eight, girls of the higher classes are shut away from the sight of men in rooms in which oiled paper is often used to obscure the windows In the absence of ultra-violet rays a deficiency of calcium occurs which in the case of expectant mothers becomes so accentuated by the drain on the calcium of the system that softening of the bones and curvature of the limbs result. Women of the lower classes working in the open sunlight, but with much inferior food, are in perfect health.

Dr. Kathleen Vaughan, who has spent much time in investigating this disease, states "the observed facts convince me that want of light is the essential cause," and, again, "I have not seen much benefit from cod liver oil unless light is allowed."

The inhabitants of the Faroe Islands and of Iceland live on similar food, which includes much cod liver, yet rickets is prevalent among the former and absent from the latter. It is significant that the Faroes experience dense

mists of long duration, which make the climate far less sunny than that of Iceland.

Ultra-violet radiation not only assists the formation of sound bone and teeth, but also increases the bactericidal power of the blood, thus helping it to resist infection. It has recently been said that a mustard plaster will produce as much increase in the bactericidal power of the blood as a treatment with ultra-violet rays. As, however, it would be necessary for the plaster to have an area equal to one-sixth of the whole body, and for it to remain two hours in contact with the skin, it is hardly likely that any would wish to repeat the dose.

Dr. Leonard Hill has indicated in his recent book, "Common Colds," that the healthiest condition would be achieved if we could live in direct sunlight with scanty clothing, the feet being kept warm and the upper part of the body cooled by outdoor breezes. Whilst, however, outdoor sunlight is ideal under reasonable climatic conditions, modern life prevents the majority of us from enjoying this.

Office work must be carried on under conditions in which there is a protection from wind and weather, and even in the case of schools it is desirable at least to provide roofs to protect the children from the rain. "Vita" glass therefore comes to our aid in helping to give us the next best thing to direct outdoor sunlight, and makes it possible for us to have windows which at any rate will not remove the most beneficial part of natural light. The special property of the glass should never be used as an excuse for keeping windows shut when they might well be opened to admit both air and sun. In fact many successful installations with sliding roofs or windows give the fullest access to open air. The glass has already been adopted in over 180 hospitals in this country, being used particularly for roofing open-air wards and for sun lounges, etc. This glass is exclusively a British product, and it is interesting to note that its use is also extending rapidly in the United States.

Much more extensive is its use in factories, offices and private houses, where it is the means of giving some of the benefits of outdoor sunlight to those who otherwise during the greater part of the year would have little opportunity of exposure to the beneficial rays.

It is frequently supposed that direct sunlight alone contains the natural health rays and can give benefit. This is not the case, however, for the light derived from the clear sky is rich in the ultra-violet rays. The blue skyshine of the unclouded sky is due to the "scattering" of the sun's rays by particles in the atmosphere which are small compared with the wave length of light. This "scattering" is much stronger in the case of the short ultra-violet waves than of the longer visible waves and, when the sun is shining in a clear sky, a horizontal surface receives considerably less ultra-violet radiation from the direct sunshine than from the whole of the sky minus the sun. As the skyshine is much cooler than the sunshine heliotherapy can be practised by exposure

to north sky in cases where it is important that there should be no subjection to heat.

This fact therefore indicates that the use of the new glass need not be confined to the parts of a house of more or less southerly aspect, though undoubtedly of greatest value in such positions. It is, however, important when the glass is used in windows facing north that these should be large, and it is desirable to be near to the window so that light from a large area of sky may be received. In the case of rooms where the natural light is weak, the glass cannot have any valuable beneficial effect.

When "Vita" glass is first exposed to sun there is a small initial loss of transparency to ultra-violet radiation, but after about a month, a steady state is reached, and there is no further loss of permeability. In most of the numerous tests which have given such good results, the glass was installed for some time before trials could be carried out, and therefore this initial deterioration had already taken effect and the glass would not deteriorate further with lapse of time.

The idea that glass having special transparency to ultra-violet radiation must be kept scrupulously free from dirt by frequent cleaning has by some means obtained wide credence. It is certainly desirable that the glass should not become begrimed with a deposit of soot, as this not only obstructs visible light but also the ultra-violet rays to a rather greater extent. It is not necessary, however, that more than ordinary precaution as regards cleaning should be taken in the case of vertical panes, and even in the case of roofs, though occasional washing is desirable, an important beneficial effect will still be secured if, as at the Zoological Gardens, no steps are taken to clean the glass.

Very frequently the questions are asked what is the transmission or efficiency of the glass and what is its price?

The efficiency figure of the glass depends on many factors, one at least of which cannot be determined with exactitude. These include (*a*) the relative beneficial effect of rays of equal intensity but of different wave-length, (*b*) the intensities of the different wave-lengths present in the particular incident light, (*c*) the transmission of the glass for rays of different wave-length.

The first of these factors itself probably depends on the use to which the glass is put, *e.g.*, prevention of rickets, etc. However, it is necessary to give some rough estimate, and we shall probably not be very far out if we take as our measure of the efficiency of the glass for transmitting natural ultra-violet health rays, the percentage transmission at wave-length 3,130 (this being convenient for measurement with a mercury vapour lamp).

The glass, recently improved as regards transmission and resistance to deterioration, after reaching a permanent condition transmits in 2 mm. thickness about 65% at 3,130, which may be taken as its approximate efficiency figure. Of the 35% diminution, 8% of the original intensity is lost simply by reflection at the two glass air surfaces and the rest by absorption.

As regards cost, it may be said that at a rough estimate, if the extra cost of a fair-sized window of "Vita" glass were spread over 20 years, it would work out at about one penny per month, or one halfpenny per week would pay for a large bay window. In new buildings the extra cost of the glass is unlikely to exceed one per cent. of that of the whole structure.

The least benefit to health to any member of the family would be cheap at this price, and it must be remembered that the benefit is received with nothing to swallow, no time to be wasted, no trouble, further expense or interference with one's ordinary life. Yet a man in an office sitting bare-headed near a window of favourable aspect may receive spread over the whole year ultra violet radiation equivalent to that received during many weeks or even months of holiday.

Transparency to ultra-violet radiation is not the only property of importance in glass of this kind. The glass must retain this transparency without important loss of exposure to sunlight, and it must be resistant to atmospheric attack. In addition, glass which is used for living rooms must be as free as possible from visible defects which would distort vision. It is possible to produce a glass of transparency to ultra-violet far beyond the limits of the sun's spectrum, but the surface of such glass becomes corroded by damp, and the material is therefore quite unsuited for windows though useful in special optical instruments.

In view of the fact that all the necessary qualities are now combined in the glass, the time may be envisaged when at least the sunny windows of all rooms, offices, and factories where people live and work will be fitted with glass which does not obstruct the most healthful rays of the sun.

DISCUSSION

The Chairman said the audience were indebted to the lecturer for his clearly delivered address and for his beautiful demonstrations and slides. He was particularly pleased that the lecturer had insisted upon the open window, because he himself had always been an apostle of open air and sunlight. In all the wonderful cures which had been gained by such men as Bernhard and others, it was not yet known to what extent sunlight, and to what extent open air, had contributed to such cures. That could only be determined by scientific tests exactly carried out. Children were cured of debility and rickets in such a town as Salford. They were kept all the Lancashire winter, in rain, mist and smoke, out of doors in an open shed, which was roofed but open otherwise to the air, having no artificial heat except for drying their clothes and warming their food. They were warmly clad and well fed. Those children became robust and excellent scholars. That was a very striking thing. Open air was necessary. It must not be thought that because children were given vita glass and arc lamps, and such artificial means, that that was the whole story, and that we could stuff ourselves indoors in heated places. We should not trust only to the vita glass, but we should let in the splendid air to improve the respiratory membrane and to enable us to fight infectious diseases. It was known that light had a profound influence on rickets, which was a disease

produced by want of light ; but the bones could not possibly ossify unless we had vitamin D, obtained from a substance which had now been isolated, formed from ergosterol. It had been isolated in the National Institute for Medical Research by Webster and Rosenheim. That vitamin not only prevented rickets, but was required for general health and growth, resistance to disease, and so on. It was interesting to consider what the total effect of the want of light on the whole nation was. We must not get exaggerated ideas. Lyme Regis had three times as much ultra-violet rays as Hull, and about ten times as much as Rochdale. Yet the death rate for Rochdale, 1926-27, was 14 to 16, while for the whole of the rural districts of England it was 10 to 12. If, therefore, the whole of the difference was put down to light, it was not very great. As he had said, we must not exaggerate. One matter to be settled was whether vitamin D would take the place of rays. There were other influences in light which were undoubtedly at work in healing tuberculosis, wounds and so on ; but we did not yet know how much ; and we wanted to find out by a very exact series of experiments how far the new discovery of vitamin D went. Could the want of ultra-violet rays in our smoky towns be replaced by giving everybody vitamin D? It was a powerful thing, and not too much of it must be given. Caution had to be exercised Some experiments recently carried out in Canada showed that in order to form vitamin D, and get this anti rachitic effect the sun needed to be above an angle of 45° to be really active. In a city like Glasgow, where for six months of the year the sun was below 45°, there was not much of that anti-rachitic power about, and what sun there was was cut out by smoke and clothes. Yet Rochdale had a death rate of 16 against 14 in the rural districts. Evidently light could be replaced to a very large extent by vitamin D. But that was not the whole of the story, and it was necessary to know what was the truth in all this business. For vita glass to be useful far more light must be got in. We should have as big windows as we possibly could. Our buildings should be altered in order to get in more light. People did not realise how little light came into the room through an ordinary window, and a great reform had to be brought about in this respect

Dr. E. J. Deck remarked that in some experiments which had been carried out at the London Clinic on the feeding of rats on irradiated food only, without irradiated bodies, it had been found that the rats had commenced to slough around the ears, so that it looked as if one could over-feed rats on ergosterol. It had been further noted at the clinic that rats which had irradiated food and irradiated bodies did not get that peculiar sloughing of the tips of their ears which the rats which only had the irradiated food did get. He would be very glad if anybody could offer an explanation of that.

A Member of the Audience asked if the lecturer could state what effect vita glass had on food or vegetables.

Mr. Lamplough replied that there had been communications from people to the press to the effect that they had had considerable increases in the size of lettuces and various vegetables by using vita glass in the place of ordinary glass. From *a priori* reasons one might hardly expect that, except possibly from a slight extra amount of heat. Nothing was really known on the point. Experiments were in progress, and it was quite possible that vita glass might produce much more vitamin in fruits, tomatoes and other vegetables. It appeared to improve the growth of flowers.

DR. KATHLEEN VAUGHAN, referring to her experience in India, said that it had been found that purdah women were always ailing, whereas the class of women who worked, for instance, on the boats and who were always in the open air, never had any trouble at all. They never went into hospital for their confinements, but carried them out naturally themselves. Since she had come home she had been investigating Dr. Janet Campbell's report on maternal mortality in England, and she noticed exactly the same thing—that maternity mortality was highest in smoky, crowded cities, or in the bottom of valleys, like Cumberland and places in Scotland, and that in localities like Shetland where the women worked out of doors the mortality was practically nil, such women having twelve and fifteen children without the least trouble, and without the assistance of doctors or midwives. That had been the case until quite recently, but now that such people were becoming more civilised, having been shut up in schools cut off from light, the women were now beginning to have trouble, and doctors and midwives were needed because the natural state of things was coming to an end. Such facts had converted her entirely to the idea of ultra-violet light and to the use of vita glass in schools.

MR. P. J. WALDRAM said the Royal Society of Arts had to be thanked for having given an opportunity for attention to be drawn to a matter of the very greatest importance. It was not usually appreciated that this country led the world with reference to ordinary daylight. For many years this country had been the only one which had retained what was known as the Law of Ancient Lights—a very ancient law indeed, going back to the beginnings of civilisation. He did hope that the present meeting would be one of many in which the matter of daylight in this country would receive attention during the next two years, as in two years' time there would be held in this country a meeting of the International Commission on Illumination—the last meeting of which had taken place in America last year, when, it was extremely interesting to note, the basic recommendations of this country with regard to daylight had received the unanimous assent of all other civilised countries.

The fact of vita glass being a British invention was one which should give us great cause for pride. It was being adopted all over the world. Unfortunately the country in which it was least appreciated, he thought, was the country of its birth; especially amongst those who should be its greatest advocates, namely, architects. He himself was an architect. We were very conservative in this country. If people spoke well of a thing one could always find somebody—generally somebody eminent—who would discover occasions on which to criticise it from all possible directions. At a recent meeting of the Royal Institute of Architects vita glass had been mentioned and had been immediately strongly criticised. One criticism had been that it was not much use putting in vita glass because there was so little for it to do. That was entirely false. The less light there was left by our close and high building schemes the more it ought to be conserved, and the more vitally important it was that the workers—more especially the typists and subordinate officials who had to occupy rooms in light wells from which very little indeed of the sky was visible—should have the best light they could possibly be given. A second criticism had been that vita glass was liable to rapid deterioration. He therefore welcomed the lecturer's figures with regard to that matter. The difficulty of solarisation had been known for some time, but statements of the wildest description had got abroad. He had heard it stated that vita glass lost about 50 or 60 per cent. of its efficiency in a couple of years. He hoped the lecturer would criticise that as sheer nonsense. If architects were going to specify this

sort of glass they should be in a position to have a guarantee that it had been properly seasoned, properly solarised, and that the qualities which remained in it after that maturing process were such as were approved by the medical profession. Another criticism which had been offered to vita glass was that its appearance was not so good That was a matter entirely for the architects One could not object to that criticism, but he had ventured to suggest that it should be realised that vita glass was a great triumph for British science, and that architects should be as tender as they could with the inherent defects of its infancy He felt sure that the firm who were most associated with vita glass would as quickly as possible remove from it those defects to which objection had been taken, if in fact such defects were to be found in the vita glass on the market to-day

CAPTAIN SIR ARTHUR CLARKE, K.B.E., said he had some little knowledge of the value of vita glass not as a medical man or a scientist, but as Chairman of the Seamen's Hospital Society He wished he could show the audience the wonderful organisation there was at Bramshot, which was under the charge of Sir Henry Gauvain and Dr Wood That organisation was a hospital for seamen suffering from tuberculosis, and he could vouch for the wonderful effects of open air and vita glass on those cases He desired to ask the lecturer whether he would recommend vita glass above open verandahs, the men lying on their couches, or merely pure sunlight. He had seen the men so brown that he had scraped them as he did not think the colour was natural and he would like to know whether that was caused by the vita glass or the pure sunlight

The lecturer had cleared up one point which had always puzzled him. He had gone to sea fifty seven years ago as a small boy in an East Indiaman. The food had been bad beyond compare Yet the whole ship's company had been extraordinarily healthy, despite bad food and having to work anything from sixteen to twenty hours a day in wet, cold and freezing weather Probably the ship's company had been so healthy because they had always been working in the open air.

MR L. WARD said he had been hoping the lecturer would have given some statistics showing the benefits to factory workers where vita glass had been introduced. It would be a good thing to keep records in those works in which vita glass had been installed. It was quite a common custom in many works to limewash the windows and the fanlights during the summer months, and he wondered what effect that would have on vita glass. He presumed it would nullify its effects.

A MEMBER OF THE AUDIENCE said he gathered the lecturer did not advise the use of vita glass for north lighted windows One gentleman had suggested that it should be used for light wells. But would vita glass be justified for light wells if it was not justified for north lighted windows?

DR. ALBERT EIDSON desired to mention that the difference between ultra-violet glasses and ordinary window glass was that the former transmitted a range of from 3,300 down to 3,000 Angstrom units That was a marked difference. Would it be right to assume that those 300 Angstrom units were the only vital rays which affected health and produced the marvellous results which had been described in animal experiments? Animals are covered with fur and the actual amount of skin exposed to the rays, therefore, is very small. Another thing which had to be borne in mind was that the actual quantity of ultra-violet rays necessary to produce the anti-rachitic substance was very minute. So far as animals were concerned, the longer rays -rays beyond the 3,300 region which

would go through window glass with just as much ease as they would go through any ultra-violet light glass, had important biological action and until the facts had been clearly proved on a firm scientific basis, and until it was discovered which factors were really responsible for the effects obtained, it was not justifiable to spread too widely the advantages of a glass which was really only in a very early and experimental stage of development. The cures which had been made were due to a combination of open air and light, and it was not yet known how much of the cure was due to the open air and how much to the light, nor even how much was due to heat, or to visible rays or to ultra-violet rays. Was it justifiable, therefore, to say that every piece of window glass ought to be scrapped and that vita glass should be used throughout the country on the evidence available at the present moment?

THE LECTURER, in reply, said with regard to the matter of the appearance of the glass, the gentleman who had raised the point had probably based his remarks on the appearance of the glass in its very early days. At the present time its appearance was exactly the same as that of ordinary glass. It was impossible to tell the difference on a visual inspection. The same gentleman had also raised the point of deterioration. Apparently the source of that rumour was the Bureau of Standards in America, which had stated that solarisation was "complete" in a month. What the Bureau of Standards had meant, however, was that the fading process went as far as it would go in about a month's time. Many people had taken that to mean that the glass solarised or faded to nothing, and that all its valuable properties had disappeared, after a month. It was very important that that misunderstanding should be cleared up. The lecture experiments had been conducted with vita glass which had been completely stabilised by long exposure to light. As regards the question of visible defects, vita glass was now indistinguishable from ordinary plate and sheet glass except by its whiter colour.

Statistical records in factories were very hard to get, because it was difficult to get exactly comparative circumstances. Lime washing of the glass would detract very considerably from its properties.

No trouble could arise with regard to the influence of vita glass on eyesight as the glass did no more than give the effect of natural outside light.

He had not said that vita glass was no good for north lighted windows. What he had stated was that in the case of north windows it was not so valuable as in sunny windows. The windows should be large and a person should get reasonably close to them in order to gain benefit from a considerable expanse of sky.

In connection with the question as to whether human beings were subject to the same wave lengths as animals, the lecturer said that it was rather difficult to expose one set of children definitely to bad conditions in order to compare them with a set of children under good conditions; but there was a great deal of indirect and some direct evidence as to the incidence of rickets in the absence of ultra-violet radiation. The blood was more or less similar, he supposed. There was no question whatever in the case of rats and chickens that ordinary glass absolutely stopped all rays which had the property of giving protection against rickets, and therefore in the case of natural light the anti-rachitic rays must lie between 3,000 and 3,300 A.U.

In conclusion, he desired to say how very important had been the encouragement given by Dr. Hill in the early stages of investigations when most other people had but taken little interest in the matter.

A hearty vote of thanks to the lecturer concluded the meeting.

NOTES ON BOOKS.

THE FINISHING OF JUTE AND LINEN FABRICS. By Thomas Woodhouse. London: MacMillan & Co., Ltd. 15s. nett.

The wide range of subjects within the purview of this valuable text book are indicated in the preface, and give a clear idea of the complexity of the work included in operations apparently so simple as the finishing of jute and linen fabrics.

Stripped of technicalities the essential function of these processes is to treat piece goods woven from flax or jute yarns so that the appearance shall be improved, and the serviceability enhanced, without impairing the utility and durability of the fabric. Any process which departs from this basic principle violates the obligation conferred on the finishers by detracting from the real value of the material handled

Linen must be pure white, smooth in surface, carefully lapped and with perhaps a pretty picture gummed outside the piece to attract potential buyers. Housewives have ceased to ask what sacrifices in strength have been made by processes which involve the use of chemicals, severe beetling, and vast pressure in the mangle in order to secure the desired results In this way the life of the fabric is probably halved.

Before the mechanical era, linen was spun and woven by hand; the yarn was boiled and the cloth was spread out on grass to improve the colour. Such linen, after several years of use, acquired a whiteness and finish which, if not up to modern standards, satisfied the consumer, both as regards appearance and durability, and there were no public laundries to rend and wear out garments.

The author explains how the simple cleansing process is still used largely for the heavy canvas, tents, ducks, and so-called brown cloth, and for materials used for packing purposes, where strength is of all importance and colour unmaterial. His definition of finishing makes clear the desired end

This is tersely described thus in Chap. IV. p 26

> "The fundamental principle underlying all these finishing operations seems to depend upon the fact that cellulose, in general, and therefore all vegetable fibres, retains the form and appearance that is imparted to it while in a moist or damp condition, provided this form is fixed by the immediate drying of the fabric."

while three conditions are stated as necessary for the successful finish of a cloth made from yarns of vegetable fibres:

1. A sufficient percentage of water in the cloth
2. Means of imparting different pressures for the purpose of flattening the yarns in the fabric to the proper degree
3. Sufficient heat rapidly to evaporate the excess of moisture added in the damping process"

The first of them raises a most important subject. Upon the percentage of water naturally contained in fibre depends its strength. A point is reached where the fibre is in perfect condition for spinning or weaving, but no scientific data have hitherto been evolved, and the factor varies according to season and to climate. That certain districts such as Belfast, Fifeshire, Ghent and Lille have successfully established linen manufacture depends, not on fortuitous chance, but on favourable climatic conditions. The former is famous for its bleaching and finishing, and the aim of the "finisher" throughout the world is to emulate the perfection there attained.

The author alludes to the addition of moisture in order to protect the cloth from

the evaporation due to the generation of intense heat during the finishing process. Here is direct evidence of the damaging effect on the fabric; but public demand must be satisfied, and it is not within the scope of the author's work nor of this critique to suggest the education of the consumer so that he or she may demand the finish which will conserve the natural strength and beauty of the original fabric. This raises an important issue, whether a manufacturer should apply the acid test of utility to the choice of processes, trusting to the buying public being trained to appreciate and support the effort.

It matters less in the case of jute, where a smooth surface is essential for bagging articles like flour and coffee when loose fibre would injure the contents of the sack. Moreover, jute bags are frequently used but once.

The chapter on packing contains useful hints to other industries where tight pressing of materials either raw or manufactured is required to secure a reduction of freight on long ocean voyages.

Bag and sack cutting and marking machinery is treated at some length and should provide valuable reading for a wide range of readers outside jute and linen centres. Bags are now made all over the world, and binder twine makers, for example, in U.S.A., Canada, and European countries will find this text book a useful addition to their libraries.

The process of starching calls for more than mechanical treatment; research work might here be well applied to a study of starch and an application which will avoid mildew and staining in damp and tropical climates.

The last chapter pays a tribute to the high mechanical skill which has evolved types of machinery capable of reproducing embroidery and hem-stitching, once exclusively the product of hand labour. Our shop windows bear testimony to the successful application of this art, which gives promise of a revival in the demand for linens so sorely needed at this time.

Mr. Thomas Woodhouse has exhaustively treated his subject from every standpoint, and his illustrations and text provide a hand-book which should prove of great value to men employed in this line of industry, enabling them to acquire a sound foundation in the technique of their trade, such as they could scarcely hope to attain after many years of practical experience in the factory. Nothing but praise is due to the effort which succeeds in providing a text-book which enables a young man to acquire in advance such wide knowledge of general practice as a foundation for the acquisition of practical experience in any particular class in which he may specialise.

The book is written in a style that all may understand. It would be impossible to improve on the illustrations, and the paper and make up are of a quality to stand daily usage. The reference to machine makers' names should prove helpful, especially to foreign students.

OLD GLOUCESTERSHIRE CHURCHES. By W. Hobart Bird. London: Ed. J. Burrow and Co., Ltd. 6s. 6d. net.

We have already noticed in this *Journal* a very interesting book by Mr. Hobart Bird on the mural paintings in the Gloucestershire churches. Mr. Bird is a learned lover of this county, which among its rolling hills and in its bluish villages maintains that "old-world" atmosphere which is nowadays so often invoked and so much less often found.

This "concise guide," the author tells us, was largely compiled for motorists. It is to be hoped that the people who in increasing numbers take the road every fine week-end will, also in increasing numbers, give themselves an architectural

objective, and not merely content themselves with the satisfaction of eating up so many miles of highway—and the usual third-rate meals with which our inns provide their guests. Even the horseradish for our beef to-day mostly comes out of bottles.

In Gloucestershire, as Mr. Bird says, the ancient churches include in their number good examples of every style of English Gothic. Motor pilgrims could have no better ground for the study of Gothic architecture and of the intimate history of the middle ages, bound up as this was with things ecclesiastical. To them Mr. Bird's book would be an ideal guide, for the details it gives are at once instructive to the novice and informative for the connoisseur.

A useful introduction mentions the chief features embodied in Gothic churches, naming their relevance to religious practices and explaining the opportunities they offered to the artists and craftsmen of former days. In sculptured tympana, carved pulpits, wall-paintings and brasses, the Gloucestershire churches are rich. Screens, rood-lofts and fonts of interest abound; there are many stone effigies, and two of wood dating from the thirteenth century. Puritan iconoclasm, fortunately, spared some of the wonderful stained glass in the county; "the great East quire window of Gloucester Cathedral is said to be the largest in existence." And not only the largest, but a very fine one.

Plate 9 exhibits some interesting contrasts. The Chipping Campden altar tomb, with its Corinthian columns, presents its own contrasts, for it was set up in that early renaissance period of transition which gave us Audley End, Barghley, and other great houses which may or may not have been built by Thorpe. In his classical resting place lies the effigy of a mediaeval knight, his arms cut in relief on a pediment somewhat too steep for the proportions of the tomb as a whole.

What looks queerly like mosaic in the photograph of the chancel at Hampnett is really modern stencilling, deplored by Mr. Bird as interfering with due appreciation of the architecture, which has all the integrity of the best Norman work.

The church at Deerhurst is not only Saxon, but has a handsome tower, illustrated on Plate 3, and a font, Plate 11, "the best preserved and most ornate Saxon font in existence." The fine fifteenth century tower at Yate is one of not a great number of Gothic towers which by their proportions really contribute to the formal excellence of the church or other building of which they are a part. At Princeton University in America there is a kind of neo-Gothic tower that splendidly conveys an impression of size and dignity; few are as exquisite as those at Magdalen College and Yate.

Oddington, which figured prominently in Mr. Bird's book on mural paintings, has besides its celebrated "doom" a Jacobean oak pulpit, Plate 11, and a mass-dial on the porch wall.

Curiously enough Mr. Bird says of the gargoyles at Winchcombe that they are "unbeautiful," while presenting three of them to his readers. Gargoyles play an important part in the history of caricature, and like caricature they can have æsthetic beauty. Even to those prompted by a most secular desire to ridicule and distort the human countenance did the church thus offer their opportunity. The forty gargoyles of Winchcombe are not to be brushed aside, and perhaps not to the present reviewer alone would be one more incentive to spend a holiday looking at Gloucestershire churches.

This is indeed a most admirable little book, and it would be improvident to travel without it in the region Mr. Bird knows so well and serves in more ways than one.

P.B.

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FRIDAY, JULY 5th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICES.

INDIAN SECTION COMMITTEE.

A meeting of the Indian Section Committee was held on Wednesday, June 26th to consider the arrangements for meetings of the Section during the forthcoming session. The following were present :—Sir Reginald Mant, K.C.I.E., C.S.I., in the Chair; Sir Charles H. Armstrong; Lord Askwith, K.C.B., K.C., D.C.L.; Sir M. M. Bhownaggree, K.C.S.I.; Sir Atul C. Chatterjee, K.C.I.E.; Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Brig.-Gen. Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G.; Major H. Blake Taylor, C.B.E.; Mr. Carmichael Thomas; Dr. J. A. Voelcker, Ph.D., F.I.C.; and Lieut.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary of the Society), and Mr. W. Perry, B.A. (Secretary of the Indian Section).

DOMINIONS AND COLONIES SECTION COMMITTEE.

A meeting of the Dominions and Colonies Section Committee was held on Wednesday, June 26th, to consider the arrangement for meetings of the Section during the forthcoming session. The following were present :—Major Sir Humphrey Leggett, R.E., D.S.O., in the Chair; Lord Askwith, K.C.B., K.C., D.C.L.; Rear-Admiral James de Courcy Hamilton, M.V.O.; Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.; Major H. Blake Taylor, C.B.E.; Mr. Carmichael Thomas, and Lieut.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary of the Society) and Mr. W. Perry, B.A. (Secretary of the Dominions and Colonies Section).

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The One Hundred and Seventy-fifth Annual General Meeting for the purpose of receiving the Report of the Council and the Financial Statement for 1928, and also for the election of Officers, was held in accordance with the Bye-Laws, on Wednesday, 26th June, at 4 p.m. SIR GEORGE SUTTON, Bt., Chairman of the Council, was in the Chair.

THE SECRETARY read the notice convening the meeting, and the Minutes of the last Annual General Meeting, held on June 27th, 1928.

THE SECRETARY then read the following:—

REPORT OF COUNCIL.

I.—ORDINARY MEETINGS

The One Hundred and Seventy-fifth Session of the Society was opened by the Chairman of the Council, SIR GEORGE SUTTON, who chose as the subject of his address "Fifty Years of British Industry." Among the many changes that have taken place during this period none is more striking than the increase in the scale upon which enterprises are now conducted—a tendency which is still being accelerated as large firms amalgamate and groups are established within particular industries. Some of the effects of this tendency were illustrated by the Chairman from the Cable Makers' Association, in the formation of which he has played a leading part. Amalgamation secures greater economy in production, management and salesmanship, greater financial stability, and a firmer hold over raw materials and the conditions of sale for the final products. Perhaps an even more important point is its bearing on research. Some idea of what can be done in this way by a great firm was given in a paper read by Mr. Percy Dunsheath in 1926, entitled "Science in the Cable Industry," when he described the research department of the firm over which Sir George Sutton presides. A task of this magnitude can, of course, only be undertaken by a large and wealthy undertaking. The Chairman also referred to the changes brought about in the last half-century in the relations between employers and employed and the efforts to secure peace in industry, and he described—perhaps more forcibly than they have ever been described before—the ideals which inspire the man of affairs to build up great industrial or trading concerns.

MR. OMAR RAMSDEN, in his paper, "English Silver and its Future," referred to what he had recently seen in half-a-dozen European capitals—splendidly appointed shops full of beautiful silver, which formed a striking contrast to the stereotyped and uninteresting displays which appear in many British shop windows. He is of opinion that we are in too much of a rut,

and content to serve up reproductions or re-adaptations of antiques instead of encouraging a style founded on our national traditions, but developing naturally on fresh lines. Although taking a somewhat gloomy view of the present position of English silverwork, he is far from pessimistic as to its future. We have many admirable artist-craftsmen amongst us, and he thinks that if they are given a chance and if "artist, designer, master and man" will consent to sink their differences and pull together, this country may yet regain her position as a leader in the world of applied art.

"Forestry in Sweden: its Importance to and Influence in Great Britain" was the title of a paper by PROFESSOR E. P. STEBBING. The total forest area of the country amounts to about 58 million acres, and timber and paper pulp bulk very largely in its exports. The paper gave an account of the administration of the forest lands and the legislation dealing with them, and then proceeded to describe methods of sylviculture, including the planting, thinning and felling of trees. Professor Stebbing urged that foresters of this country might profit greatly by studying forestry management in Sweden, and he specially urged the desirability of making experimental plantations on a considerable scale by direct sowing instead of by the costly plantings which are so widely adopted in Great Britain.

The value of London's imports and exports in 1926 reached the prodigious total of nearly £702,000,000. How this merchandise is dealt with was described by MR. J. H. ESTILL in his paper, "The Port of London." About 35,000,000 tons of goods annually enter the Port, of which the water area in the docks is 720 acres with 36½ miles of quay. Particulars were given of the London, Surrey Commercial, West India, Millwall, Royal Victoria and Albert, and King George V Docks, and of the most recent developments which are now taking place at Tilbury. The vast warehouses controlled by the Port of London Authority were also described and many interesting figures were given to illustrate the amount of trade in different commodities. A remarkable illustration was given of the effect of fashion on trade. A few years ago ostrich feathers of the value of some £3,000,000 passed each year through the warehouses. This trade is now practically dead, and its place has been taken by that in silk stockings.

A great deal of public interest was attracted to the paper "Fuel for Ships," by SIR EUSTACE TENNYSON D'EYNCOURT, in which attention was drawn to the possibilities of pulverised coal. The depressed condition of the mining industry in this country, and the enormous loss of markets which it has recently suffered make it necessary that no stone should be left unturned in finding uses for what has long been one of the principal sources of our national wealth. So far as fuelling and furnace feeding are concerned pulverised coal shares many of the advantages of oil. Much research has been carried on and is still proceeding as to the use and storage of powdered fuel. Sir Eustace summarised the results of this work and came to the conclusion

that, if the ratio of the cost of coal to that of oil remains as at present, the improvements that are rapidly being made to use coal and steam in the most economical manner should lead to a very considerable demand for pulverised fuel. A great deal of spade work, however, still remains to be done in devising the best methods of conveying the coal into ships and of handling it when on board.

"Applications of Electricity to Medical Practice" was the title of a paper read by MR. G. G. BLAKE, who in his capacity as Hon. Radiographer in charge of the X-ray Department of the Star and Garter Home for Disabled Soldiers and Sailors, has had a very wide and varied experience of this subject. After touching on the uses of electricity in ordinary X-ray work for the detection of injuries, etc., the employment of ultra-violet rays for general and local treatment of diseases and the introduction of medicines into the body by electricity, Mr. Blake demonstrated the methods of measuring and recording human emotions by means of the thermionic reflexometer; he also showed how it is possible to localise exactly the position of such a foreign substance as a bullet in a human body by means of stereoscopic radiography, and he described the action of currents of high potential in therapeutics. The paper was illustrated by a large number of practical demonstrations, which conveyed a striking idea of the many ways in which electricity is now being employed in medicine and surgery.

It is estimated that five-sixths of the smoke discharged into the atmosphere of London is of domestic origin. The purification of this atmosphere is therefore mainly a domestic problem; while considerable improvement has taken place during recent years, much remains to be done. PROFESSOR CHARLES R. DARLING, in his paper, "The Domestic Smoke Problem: a Practical Solution," described some of the latest kinds of smokeless fuels and the most up-to-date methods of burning them The Englishman loves his bright open fire, and most medical men agree that it has far more than its æsthetic virtues to justify it. Recent research has solved the problem of kindling and burning coke in an open fireplace, and other solid smokeless fuels are now on the market. Most of these were described in the paper, and their comparative costs were discussed. The lecturer urged that in the designs of all new houses the ordinary coal fireplace should be removed in favour of smokeless fireplaces. In this way a great advance would be made towards abating the smoke nuisance.

A somewhat woeful picture was painted by SIR HENRY MIERS in his paper, "Museums and Education," of the state of many of our provincial museums. Overstocked with heterogeneous collections of "curios" dumped upon them by people who have no further use for them, these unhappy places are filled with cases of moth-eaten birds and beasts, odds and ends of shells and minerals and what not. So far from playing any part in the life of the towns which they cumber, many of them are hardly known to the inhabitants. Depressing

as the description is, one knows that in many instances it is only too true. And yet, as must be obvious to every one, there are immense educational possibilities in museums. The problem is—how to make the most of them? Get rid of the rubbish, would seem to be the first step. Accept only with discrimination, and try above all things to bring your museum into some relation to the interests of the town in which it is situated. If among your exhibits you can illustrate the history and development of some local industry your museum will have real interest and value for those who visit it.

Under the Trueman Wood Trust, which was established to commemorate the long services of the late Secretary, twelve annual lectures have now been delivered, and they form a remarkably brilliant series. The list is as follows:—

"Discovery and Invention," by Sir Dugald Clerk, K.B.E., F.R.S.
"Glass and some of its Problems," by Sir Herbert Jackson, K.B.E., F.R.S.
"Sources of Power, known and unknown," by Sir Oliver Lodge, F.R.S.
"The Present Position of Research in Agriculture," by Sir Daniel Hall, K.C.B., F.R.S.
"Long-Distance Radio-Telegraphy," by Professor (now Sir) J. Ambrose Fleming, F.R.S.
"New Methods of Crystal Analysis," by Sir William Bragg, F.R.S.
"The Outlook in Chemistry," by Sir William J. Pope, K.B.E., F.R.S.
"The Stability of Atoms," by Professor Sir Ernest Rutherford, F.R.S.
"The Modern Note in Industrial Art," by Sir Cecil Harcourt-Smith.
"The Progress of Economic Entomology (with special reference to Australia and New Zealand)," by Professor R. J. Tillyard, F.R.S.
"The Wider Aspects of Cosmogony," by Sir James H. Jeans, F.R.S.
"The Vibrations of Railway Bridges: an Example of Co-operative Research," by Sir J. Alfred Ewing, K.C.B., F.R.S.

The very high standard of excellence set up in this series was more than maintained by SIR ALFRED EWING. He gave a masterly summary of the work of the Bridge Stress Committee, a body which has been investigating for the last six years "an old and puzzling problem of engineering—what is called the 'impact' or dynamic action of a train moving at high speed over a railway bridge." Apart from its importance from the engineering point of view, the research had a special interest as a piece of team-work. Under the auspices of the Department of Scientific and Industrial Research, it brought together the British Railway Groups, who not only contributed financial help, but also provided all the practical facilities necessary for conducting the work, and many engineers of experience and experts in theory. The principal problem before the Committee was to investigate what is known as the "hammer-blow"—in other words, the periodic variation of the vertical force exerted on the rails by the locomotive. Over fifty bridges, of spans ranging from 10½ feet to 345 feet, were tested, a large variety of locomotives being run over them. The results were most carefully recorded by mechanical means, and the relations between the amount of the hammer blow and the amount of cumulative oscillation set up in the bridges were thoroughly

investigated. The results obtained by the committee have rationalised the treatment of a very difficult problem, and should prove of the utmost value to all railway engineers.

In his paper, "The History of the Development of Fast Dyeing and Dyes," MR. JAMES MORTON related a story of apparently insuperable difficulties triumphantly overcome. Up to 1914 the manufacture of Sundour fabrics had come to depend almost entirely on Germany for certain dyes, especially the yellows and blues. The outbreak of war suddenly stopped the supply of these essential products, and the business was seriously threatened. Mr. Morton, however, rose to the occasion. With the aid of his chemical staff he traced the synthesis of two very obscure dye-stuffs, and in 1915 they actually produced for the first time in this country Indanthrene Yellow and Indanthrene Blue. In the most favourable circumstances this would have been a very brilliant feat, but when the circumstances of the time are taken into account—the extraordinary difficulty of obtaining any raw materials and apparatus, and the patriotic necessity for carrying on at the same time the manufacture of such vital supplies as army blankets—the triumph becomes heroic. Further successes have in recent years been placed to Mr. Morton's credit—most noticeable, perhaps, being the production of Caledon Jade Green. The paper disclosed one of the greatest industrial romances in the history of this country, and one which was hitherto known only to a few.

"East Indian Copals and Damars" was the title of a paper by MR. A. I. SUTER, who gave the latest information on the production of these materials gathered during a recent prolonged tour in the East Indies. Macassar or Manilla copal is derived from a single plant, the *Agathis alba Foxw.*, which occurs most frequently in the Dutch East Indies, the Celebes, the Moluccas, Borneo, Sumatra and New Guinea. Copal is the natural exudation from the bark of this tree at places where it has been injured. The native methods of tapping the trees were described, and the measures which have been taken by Government administration to prevent their destruction by over-tapping. After the copal has been collected the next step is to grade it, which is mainly done by women, native or Chinese. Four points have to be borne in mind in the grading; hardness, colour, purity and size. Until recently copals were exclusively employed in the manufacture of varnishes. Synthetic resins, however, are now coming into vogue, and the natural products seem to be losing favour in some quarters; but Mr. Suter believes that, given accurate standardisations of the copals, they will hold their own against this competition.

A question of considerable importance to fruit growers was discussed by MR. CECIL H. HOOPER in his paper, "The Study of the Order of Flowering and Pollination of Fruit Blossoms applied to Commercial Fruit Growing." In planting orchards, whether of apples, cherries or other fruit, it has long been customary to mix the varieties, and also to keep bees in the near neighbourhood.

and recent research has proved the value of both practices; but at the same time care must be taken to ensure that the varieties selected should flower at the same time: otherwise it would be impossible for the one kind to fertilise the other. Mr. Hooper has for many years carefully studied the question as to which varieties of fruits should be planted together, and the results of his observations were set forth in a number of valuable tables.

The remarkable hydro-electric development which is now being carried on in Ireland was described by Mr. George Fletcher in his paper, "The Shannon Scheme and its Economic Consequences." The Shannon is the longest river in Ireland with a catchment basin of over 4,000 square miles. The power house is situated at Ardnacrusha, a few miles above Limerick. The three turbines to be installed will have an output of 38,600 h.p. The current will be distributed by means of overhead high-tension transmission lines over nearly the whole of the Irish Free State, and the erection of these lines is now in a very advanced stage. With regard to the economic consequences of the scheme, Mr. Fletcher pointed out that the primary economic need of the Irish Free State is cheap electric energy for lighting and power purposes. Although it is not possible to state at present to what extent the supply will be utilised in agriculture it is hoped that, with adequate propaganda, the farmers will be induced to realise the assistance that they can derive from it, and further there appears to be reason to expect that new industries which require cheap power may be induced to start in the country.

The inauguration of broadcasting six or seven years ago at once created an enormous demand for "a powerful electrical instrument which should be capable of imitating at a moment's notice the human voice, a violin, a tinkle, a crash, a piano, a drum, or a complete orchestra." Mr. R. P. G. Denman, in his paper, "Loud Speakers and their Development," summed up the situation as it stands to-day. The immense advance that has been made recently was demonstrated by the collection of loud speakers shown at the meeting. The construction of each of these was fully described, and its characteristic features discussed. Admirable as these latest instruments are, a great many scientific workers are engaged in bringing them to still higher perfection. With the enormous financial resources of the gramophone and motion-picture industries to call on, it is probable that striking developments will be made in large auditorium instruments, and that the loud speaker used for domestic purposes will either retain its present form or else will gradually give place to small-scale examples of the larger types.

"Commercial Art" was the subject of a paper read by Mr. Tom Purvis himself one of the most successful and brilliant of our poster artists. The relations of the commercial artist to the firm for which he works were discussed in some detail. Whilst claiming for the artist a reasonable amount of liberty in the actual carrying out of his design, Mr. Purvis made it clear that he ought always to bear in mind the object for which the poster is produced, and

work in the closest touch and sympathy with the commercial side of the firm: the poster, in short, should be the result of close team-work between the artist, the manufacturer and the salesman. Passing on to the design and execution of the poster, the lecturer discussed the uses of colour, and the importance of getting a broad effect which should convey its message instantaneously to the passer-by. To achieve this it is often advisable to omit all but the boldest features, a practice which is followed by the most successful poster artists of to-day.

In dealing with the subject of "Modern English Architecture," PROFESSOR A. E. RICHARDSON threw on the screen a large number of photographs of buildings to illustrate:

(*a*) Commercial architecture—offices, banks, warehouses, factories, transport buildings.

(*b*) Housing—town and country houses, cottages, farms, etc.

(*c*) Civil—post offices, town halls, schools, bridges.

(*d*) Religious buildings—cathedrals, churches.

With regard to (*a*), we have yet to devise the efficient factory, the attractive city office, the best form of garage, and the right type of bank, the last of which is generally a classical building bedizened with unnecessary ornament. The housing question has evolved a new cottage style for villages and garden cities, and some of the pictures shown represented a very successful grouping of pleasant houses. When discussing group (*c*), Professor Richardson paid a handsome tribute to H.M. Office of Works under whose auspices many admirable post offices have been erected in various parts of the country. He also drew attention to the new steel bridge at Newcastle-on-Tyne, which he characterised as a thing of beauty. By way of comparison, a number of slides were also shown to illustrate recent developments of architecture in Denmark, Sweden, Germany, France, Holland and America and in conclusion Professor Richardson read a short imaginary paper, supposed to be delivered a century hence, in which he referred to the masterpieces of some of the best architects of 1929 and threw out suggestions as to the way in which architecture and life will have developed in another hundred years.

The main purpose of MR. GEORGE HOWARD NASH'S paper, "Some Modern Aspects of Electrical Communication," was to make known to those not familiar with recent developments some of the problems that arise on very long telephone connexions, the means adopted for reducing or overcoming such difficulties, as "attenuation" or "frequency distortion," "phase distortion," "echoes" and "interference," and to explain how a number of communications can be made simultaneously over a single pair of wires without interfering with one another. In any telephone circuit of either aerial or short cable lines there is available for transmission services a range of frequencies extending from zero to 30,000 cycles per second. Various communication systems have been designed to enable the maximum use to be made of this range. In order to

demonstrate their possibilities two terminal equipments were set up in the lecture hall and several simultaneous communications over the same wires were carried on by telephone and telegraph without any interference.

It is well known that ordinary window glass cuts off the ultra-violet or "health-giving" rays. MR. F. E. LAMPLOUGH accordingly set himself to discover a glass which would permit the the passage of these rays. In his paper, "The Properties and Applications of 'Vita' Glass," he gave some account of this material, which, it is claimed, transmits radiation well below wave-lengths of 3,000. In the course of the paper a demonstration was given of spectrum photography to show the transmission of these waves through "vita" glass, and the results of certain experiments were also quoted to demonstrate the beneficial effects on animals reared under it.

MR. H. LYNTON FLETCHER, in his paper, "Recent Developments in Educational Broadcasting," gave an account of what has been done by the B.B.C. to provide instruction for schools and for ordinary listeners. The regular daily transmission to schools was started in 1924, and by June, 1926, between 1,500 and 2,000 schools were on the register at London. By this time an efficient service had been organised; in many schools the pupils were regularly sending in written compositions or answers to problems, and terminal examinations had been instituted with excellent results. In the early stages there were numerous troubles to contend with. For instance, in many schools the reception was very bad and the difficulty of following the lessons naturally led to inattention in the classes. In some places the innovation was eyed with suspicion by the teachers, who feared that they might be supplanted by the wireless lessons. These and other difficulties and misconceptions have now been largely removed, and education by broadcasting is coming to be recognised as a supplementary but stimulating and valuable addition to the ordinary school curriculum.

Many people have considerable difficulty in understanding ordinary architectural plans and elevations, and even those who are accustomed to dealing with them every day do not always find that when they are executed in building materials the results are exactly what they intended. In his paper, "Building Models," MR. P. MORLEY HORDER urged the desirability of architects making models in addition to plans and elevations. Most clients can understand these readily, and many architects can learn a good deal from seeing what they propose to build in this form. It is not suggested that for ordinary purposes the models should be at all elaborate; they are made of the simplest and most inexpensive materials, so that they can easily be altered if any changes in the design are necessary, and when the building is completed they can be destroyed without much loss.

In illustrating his paper, "War and its Influence on the Arts," MR. CHARLES FFOULKES showed a large number of slides of military pictures, ranging from the Norman Conquest to the present day. In most of these the soldiers,

whether Israelites or Charlemagne's paladins, were equipped in the armour of the artist's day. From the eleventh to the sixteenth century the artist possessed no antiquarian knowledge, and his pictures are valueless as throwing light on anything but contemporary costume. Further, until recent times, there was always a tendency to depict troops on a battlefield as immaculately groomed as if they were on parade; it is only of late, and particularly in the work of those artists who painted scenes of the Great War, that sincere efforts have been made to portray war as it really is. Most of these came from the hands of painters who were at the front themselves, and shared the dangers of the fighting men, and their object was to paint the truth and not fancy pictures in which well-equipped troops with flying colours were always defeating a panic-stricken enemy.

The British Science Guild have recently published an important report on the British Patent system, and with a view to rousing public interest in the matter the Council invited Mr. Robert Burrell to read a paper on "The Reform of the British Patent System." While expressing a very high opinion of the value of the report, Mr. Burrell drew attention to a number of points in which he thought the recommendations of the British Science Guild Committee could be improved. With regard to the question of extended search, for instance, he urged that the Treasury should cease to appropriate for other purposes monies paid by patentees as their contribution towards the cost of maintaining an efficient patent service, and he suggested the institution of a central international office for search purposes. The question of "novelty," admittedly an extremely difficult one, was also discussed, together with the extension of the protection of patent laws to inventions which are at present unpatentable, the reduction in the cost of patent litigation and the means of reducing the existing congestion at the Patent Office and the introduction of facilities for securing a quicker patent grant than is at present possible.

II.—Indian Section.

Six papers were read at meetings of the Indian Section during the Session.

The important question of "Town Water Supply in India" was the subject of a paper by Mr. J. W. Madeley. Mr. Madeley, who had been responsible for the design, construction, and maintenance of the Madras Waterworks, gave a full account of the general conditions of Indian towns in the matter of water supply. The various problems connected with the provision of an adequate water service, such as the sources of supply, plant, filtration and pre-filtration treatment, were fully dealt with, and in conclusion the lecturer emphasised the importance of co-operation and of the education of public opinion in India to an appreciation of the fact that water must be husbanded, and that its waste or pollution is a crime against society.

A good deal of attention has been given of recent years to the position of the Indian sugar industry. Perhaps the most striking factor in the situation is that, whereas about 1840 India exported to Great Britain nearly 100,000 tons of sugar per annum, in 1926-27 she imported—mainly from Java—826,900 tons, her export trade having been practically extinguished by the competition of plantation sugar produced under European management and control in other parts of the world. In a paper on the subject, SIR JAMES MACKENNA reviewed the past and present position of the industry in relation both to tariffs and such matters as the breeding of improved canes, larger scale cultivation and the introduction of up-to-date methods of manufacture. Sir James submitted that the problem must be tackled from the agricultural and manufacturing side, and contributed a number of definite suggestions for the improvement of the industry.

In a paper on "The History of the Royal Indian Marine," CAPTAIN SIR EDWARD HEADLAM traced the history of the Indian Marine Service from its first inception in 1612 down to the present day. Through the three centuries of its existence the Indian Marine has undergone a number of changes both of title and establishment strength in accordance with successive changes of policy on the part of the British Government, but it can show through its long history a glorious record of almost continuous war service as well as of the performance of much important hydrographic survey work. In conclusion the lecturer expressed his assurance that the Royal Indian Marine whose main responsibility in the future would probably be the defence of the Indian seas, coasts and harbours, would worthily uphold the great traditions of its past history and maintain an honourable position among the Navies of the Empire.

MR. W. H. MORELAND'S paper on "The Indian Peasant in History" was designed to provide an historical introduction or background to the recently published Report of the Commission on Indian Agriculture. After propounding the question why the Commission was required at all, and why it should be necessary to mobilise all the forces of India to inculcate a progressive spirit in her cultivators, Mr. Moreland expressed the view that the traditional apathy of the Indian peasant was due to the centuries-long oppression to which he had been subjected under Hindu and Moslem rule, rather than to any inherent defect of character. He was, however, showing distinct signs of recovering from the psychological effects of this regime, and there was now, he believed, "a reasonable hope that a concerted and sustained effort, such as the Report advises, may break up the crust once for all, may liberate the stores of energy which are now dormant, and may convince the peasants in the mass that it is worth their while to strive for the ideals they have never wholly lost."

In 1922 a paper dealing with the water power resources of India was read by Mr. J. W. Meares. A considerable amount of progress has been made since that date and a general survey of the present position in India in regard to the development and use of electrical energy was given by Mr. A. T. Cooper in a paper entitled "Recent Electrical Progress in India." After referring to recent developments in telegraphy and telephony and to the supply of electricity in the principal cities of India and in the territories ruled by Indian Princes, Mr. Cooper described the salient features of the most recent hydro-electric schemes, *i.e.*, the Tata Power Company's scheme for the development of water power in the Western Ghats for transmission to Bombay City, the Punjab hydro-electric scheme for the utilisation of the snow-fed waters of the River Uhl in the hills above Simla to supply electricity to a number of towns in the Punjab and also for agricultural purposes, and the Pykara-Moyar project in the Nilgiri hills in the Madras Presidency. Mr. Cooper concluded his survey with some notes on the use of electricity for industrial purposes, for coal mining, railway traction, and broadcasting.

The subject of the Sir George Birdwood Memorial Lecture, delivered by Captain P. Johnston-Saint, was "An Outline of the History of Medicine in India." After remarking upon the general ignorance which has existed in Europe for the past 200 years in regard to Indian Medicine, the lecturer referred to Dhanwantari, its mythological founder, and to the beginnings of authentic medical history associated with the names of Susruta and Charaka, the fathers respectively of Indian Surgery and Medicine, and proceeded to give an account in some detail of ancient Indian practice, which revealed some striking anticipations of modern knowledge. Captain Johnston Saint emphasised the importance of the Indian contribution to Medical Science and expressed the hope that the research work now being carried out at various centres in India would result in the restoration of India to her rightful position as the birthplace of the medicine of the world.

III.—Dominions and Colonies Section.

Four papers were read before the Dominions and Colonies Section during the Session.

The Society of Arts offered premiums and medals for maps of the counties of England as far back as 1759, and continued to do so until the beginning of the 19th century. It was, therefore, quite fitting that a paper on "Air Survey and Empire Development," by Colonel H. L. Crosthwait should be devoted to the new art of Air Survey. After emphasising the cardinal importance of correctly mapping new and little-known territories before undertaking their economic development, Col. Crosthwait proceeded to explain how an air survey is carried out, and the suitability of this method for such engineering projects as the investigation of the alignment for new railways and of sites for water-power development and water-storage schemes.

He also emphasised the fact that valuable information as to geological structure, mineralization, soil conditions, etc., is afforded by air survey.

In a paper on "The Improvement of Negro Agriculture," LORD OLIVIER showed that negro agriculture is not the irrational, "higgledy-piggledy" affair which it appears to be to the superficial European observer, but is based on a considerable amount of experience and knowledge. Native methods are, however, only suited to countries where there is a more or less unlimited supply of land, and are extremely wasteful and uneconomic when applied to land intended for permanent occupation. The lecturer laid stress on the extreme care and tact required in educating the native to improved methods of cultivation, and gave an interesting account of the operations of the Jamaica Agricultural Society, which has done a great deal of successful work in raising the standard of native agriculture in that colony.

In view of the meeting of the British Association for the Advancement of Science which is being held at Cape Town in August, it was decided to include in the programme of the Dominions and Colonies Section two papers dealing with South African mineral development. In a paper on "The South African Iron and Steel Industry" DR. H. J. VAN DER BYL outlined the previous attempts which have been made to establish an iron and steel industry in South Africa, and gave an interesting account of the recent formation, with the support and participation of the South African Government, of the South African Iron and Steel Corporation. The Corporation has been established by Act of Parliament, and its constitution is drawn on similar lines to that of the Electricity Supply Commission which was established by the South African Government in 1923, and has been highly successful, having grown in six years into one of the largest electric supply undertakings in the Empire. Dr. van der Byl described in detail the constitution of the Corporation, the main feature of which is that, after the payment of dividends of 6 per cent. on the Government shares and of 12½ per cent. on shares held by the public, surplus profits are to be devoted to the reduction of the price of iron and steel products, and also dealt with the technical aspects and commercial possibilities of the enterprise.

In a paper on "The Base Metal and Mineral Resources of South Africa," MR. H. WARINGTON SMYTH gave a review of the present position of the base metal and mineral industries of South Africa, including coal, copper, tin, lead, chrome, asbestos, soda, and a number of other metals and minerals. Mr. Warington Smyth illustrated his paper by production figures of recent years and described the special conditions of South African mining. In conclusion he expressed the view that, generally speaking, the base mineral production of South Africa is capable of indefinite expansion provided that measures are taken to ensure regularity, careful grading and uniform quality of output.

IV.—Dr. Mann Juvenile Lectures.

Under the Dr. Mann Trust two Juvenile Lectures were delivered by Captain Sir Arthur Clarke on "Ships and Lighthouses." In the first was told the story of the ship and the sailor from the time of Noah's Ark to the present day. The tale was woven round the various styles of ships, which succeeded one another down the centuries, and the sailors who fought and traded in them—the coracle of the ancient Britons, the Roman galley, the ships of the Norsemen, the Saxon ships of King Alfred, the galleons of the 16th century, the ships of Blake and Van Tromp, the ships of the line and frigates of the 18th century, the clippers like the *Cutty Sark*, and the modern leviathans such as the *Mauretania* and the *Royal Oak*.

The second lecture dealt with lighthouses, "the street lamps of the sea." Beginning with the famous Pharos of Alexandria one of the seven wonders of the ancient world, Sir Arthur described and illustrated the historical development of methods of illumination used in lighthouses– beacon fires of wood and coal, candles, paraffin lanterns, incandescent petroleum, and electric light. He also referred to the numerous modern devices for securing the automatic operation of the lights, and concluded with some remarks on directional wireless, which might be destined to become the most important of all agencies for the protection of life and property at sea.

V.—Cantor Lectures.

The first course of lectures under the Cantor Trust was delivered by Dr. Franklin Kidd on the subject of "Biology and Refrigeration." He pointed out that the preservation of food by cold is a biological problem. The living organism is controlled by environment. The relations between temperature and the rate and character of change in animals and plants were considered and some description was given of the effects of low temperature upon plants and plant produce. In the second lecture more detailed study was made of the apple as a type fruit. In preserving these account must be taken both of pre-storage factors, such as race and nutrition, and storage factors, such as temperature, humidity, atmospheric composition, etc. The third lecture dealt with the phenomena arising from the freezing of tissues, the effects depending on the rate of cooling and thawing, and on the condition of tissues, and the changes occurring at temperatures below the freezing point of water.

The unprecedented depression which has overhung the coal industry for the last four or five years has added importance to any steps towards a more scientific use of coal. Special interest was therefore taken in the second course of Cantor Lectures by Dr. C. H. Lander on "The Treatment of Coal." In the first lecture he discussed the use of coal in its raw state, especially with regard to steam raising, pulverised fuel, furnaces and process work and the production of heat for domestic purposes. The second lecture was devoted

to high temperature carbonisation processes and coke treatment, while the third dealt with low temperature carbonisation, and summed up the latest developments in connexion with hydrogenation and synthetic processes, and the combustion of oil.

VI.—Shaw Lectures.

A series of three lectures under the Shaw Trust was given by Sir Thomas Morrison Legge on "Thirty Years' Experience of Industrial Maladies." After emphasising the importance of "looks" as supplying valuable information in regard to the effects of factory life upon the health and well-being of the workers, the lecturer reviewed the results obtained by the notification of diseases—extinction or diminution in the case of certain diseases, and a stationary condition in others. Finally, he dealt with the question of compensation and the twenty-eight forms of industrial disease which have been scheduled under the Compensation Act, and illustrated the results obtained by means of a chart.

VII.—Aldred Lectures.

A considerable amount of progress has been made during recent years in our knowledge of the obscure causes and circumstances of those nomadic movements which took their rise in Asia during the dark and middle ages and threatened more than once to engulf Europe. Since the time of the historian Gibbon a number of Chinese and Persian records, which were not accessible in his day, have become available to European scholars, and in a series of four lectures on "Nomadic Movements in Asia," given under the Aldred Trust, Sir E. Denison Ross, who made full use of the latest sources of information, dealt in general outline with the four great nomadic movements which took place from the seventh to the thirteenth century.

VIII.—Albert Medal.

The Albert Medal of the Society for the current year has been awarded by the Council, with the approval of the President, H.R.H. the Duke of Connaught, to Principal Sir (James) Alfred Ewing, K.C.B., LL.D., F.R.S., "for his work in magnetism and his services to technical education."

Sir Alfred Ewing was Professor of Mechanism and Applied Mechanics in the University of Cambridge from 1890-1903; Director of Naval Education from 1903-16; and Principal and Vice-Chancellor of the University of Edinburgh from 1916 to the present date. He is the author of various books and articles in the *Encyclopædia Britannica* on the thermo-dynamics of the steam engine and of the refrigerator, while at the same time he has written important original papers on magnetism, including what is known as the hysteresis of iron.

IX.—Medals for Papers.

Eleven silver medals have been awarded for papers read before the Society during the current session—seven for papers read at Ordinary Meetings, two for papers read before the Indian Section, and two for those read before the Dominions and Colonies Section.

The awards are as follows :—

Papers read at the Ordinary Meetings :—

Sir Eustace Tennyson d'Eyncourt, K.C.B., D.Sc., LL.D., F.R.S., "Fuel for Ships"

G. G. Blake, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice."

Cecil Hooper, F.L.S., "Fruit Pollination in Relation to Commercial Fruit Growing."

James Morton, "History of the Development of Fast Dyeing and Dyes."

Professor A. E. Richardson, F.R.I.B.A., "Modern English Architecture."

G. H. Nash, C.B.E., M.I.E.E. (European Chief Engineer, International Standard Electric Corporation), "Some Modern Aspects of Electrical Communication"

Robert Burrell, Barrister-at-Law, "Reform of the British Patent System"

Papers read before the Indian Section :—

W. H. Moreland C.S.I., C.I.E., "The Indian Peasant in History: an Introduction to the Linlithgow Report."

A. T. Cooper, M.Inst.C.E., M. Cons. E., "Recent Electrical Progress in India."

Papers read before the Dominions and Colonies Section :—

Colonel H. L. Crosthwait, C.I.E., "Air Survey and Empire Development."

Dr. H. J. Van der Byl, "The South African Iron and Steel Industry."

For many years it has been the practice not to award medals either to members of the Council or to persons who have already received a medal for a paper read in a previous year. The Council were therefore precluded from considering the following papers :—

Omar Ramsden, R.M.S., "English Silver and its Future."

Professor Edward Percy Stebbing, M.A., F.L.S., "Forestry in Sweden: Its Importance to and Influence on Great Britain."

Professor Charles R. Darling, A.R.C.Sc.I., F.I.C., "The Domestic Smoke Problem—a Practical Solution."

Sir Henry A. Miers, F.R.S., "Museums and Education."

George Fletcher, "The Shannon Scheme and its Economic Consequences."

P. Morley Horder, F.S.A., "Architectural Models."

Sir James MacKenna, C.I.E., "The Sugar Industry of India."

The Right Hon. Lord Olivier, P.C., K.C.M.G., C.B., LL.D., "The Improvement of Negro Agriculture."

The Council, however, desire to express their high appreciation of these papers.

X.- Fund for the Preservation of Ancient Cottages.

This fund was inaugurated at a conference held in January, 1927, which was presided over by the Prime Minister, the Rt. Hon. Stanley Baldwin, who afterwards issued an appeal in support of it. The first general meeting of the subscribers was held on February 27th, 1929, the chair was taken by the Rt. Hon. J. Ramsay MacDonald, and he was supported by Mr. G. K. Chesterton, Sir Charles Wakefield, Mr. H. Avray Tipping, Sir Arnold Wilson, Sir Fabian Ware, and Sir George Sutton.* The first annual report, which was adopted on the motion of Mr. Ramsay MacDonald, gave an account of the work which had been so far accomplished. The Society has become the owner of Charles Lamb's Cottage, "Buttonsnap," West Mill Green, Hertfordshire, which was handed over to it by Mrs. T. F. Greg. It was mainly instrumental in saving the three beautiful Thomas a Becket cottages, near Worthing, and it has purchased and is now engaged in re-conditioning the group of cottages known as Arlington Row, in the beautiful village of Bibury, Gloucestershire. Thanks largely to the zeal and inspiration of Mr. P. Morley Horder, the Chairman of the Executive Committee of the Fund, over thirty half-timbered cottages near Shrewsbury, which in the ordinary way would have been condemned, have been saved and re-conditioned, and the general attitude of the Shrewsbury District Council is very encouraging. Various other cases in different parts of the country have been considered and assisted by the Committee.

In the annual report it was stated that the Committee were considering the possibility of securing a complete village. Shortly after its publication the village of West Wycombe came into the market. It is an excellent example of an old English rural community, and includes about fifty dwellings dating from Tudor to Georgian times, and two inns. The place depends for its livelihood mainly on the historic industry of chairmaking, and contains two factories. A feature of the street is the beautiful old "Church Loft," which dates from the fifteenth century and is in excellent preservation.

The owner of the village, Sir John Dashwood, appreciating the advantages of having at his gates a village controlled by a body with a reputation such as that of the Royal Society of Arts, agreed to sell the whole at the moderate figure of £13,500. Of this sum, £3,375 has now been paid, the remainder being left on mortgage. It is not yet possible to estimate definitely the cost of the repairs, but the Committee think it advisable to aim at a sum of £20,000.

*A full report of the meeting and of the First Annual Report was published in the Journal of March 15th, 1929.

An illustrated appeal is being prepared, and it is hoped that it will meet with a generous response.

With regard to finance, about £7,750 has now been received in subscriptions to the general fund (apart from some £1,200 subscribed to the special fund for the preservation of Arlington Row, Bibury). Of this sum, £2,025 has been contributed by Mr. James H. Hyde, for whose generous help the Council desire to express their warmest thanks. While the possession of this sum in hand enabled the Society to settle the purchase of West Wycombe at very short notice, the Council are anxious that it should not be finally depleted, and they therefore appeal to all who love the English countryside, and especially to the inhabitants of Buckinghamshire to subscribe the amount needed for the purchase and re-conditioning of West Wycombe, so that the general fund may be available for further preservation work.

It should be pointed out that the Society has placed its offices and staff at the service of the Fund for the Preservation of Ancient Cottages, without any charge, and thus the Fund has been entirely free from rent and secretarial salaries. Apart from a small sum for printing, postage and extra clerical help, there have thus been no overhead charges, and subscribers have the satisfaction of knowing that practically every penny of the money they subscribe goes directly to the purchase and repairing of cottages.

XI.—Thomas Gray Memorial Trust.

Under the Thomas Gray Memorial Trust, the objects of which are "the advancement of the science of navigation and the scientific and educational interests of the British Mercantile Marine," the Council have offered the following prizes :—

(i) A Prize of £150 to any person who may bring to their notice a valuable improvement in the Science or Practice of Navigation proposed or invented by himself in the years 1928 and 1929.

In the event of more than one such improvement being approved, the Council reserve the right of dividing the amount into two or more prizes at their discretion

Competitors must forward their proofs of claim on or before December 31st, 1929.

(ii) A Prize of £50 for an essay on the following subject :—

"You are overtaken by a revolving storm. Discuss the handling of a low-powered steamer from the time of the first indication of the approach of the storm until the storm has passed, supposing the ship to be in (*a*) the safe semicircle, (*b*) the dangerous semicircle, and (*c*) the direct path of the storm's centre."

Competitors must send in their essays not later than December 31st, 1929, to the Secretary, Royal Society of Arts, at the above address.

Similar prizes were offered last year. The judges were of opinion that none of the inventions submitted was of sufficient value to justify the full award, but on their recommendation the Council awarded prizes as follows :-

A Prize of £30 to Lieut. Donald MacMillan, R.N.R., for his "Navigator's Ex-Meridian Diagram," and

A Prize of £20 to Captain John Barrance Browning for his "Browning Star Plotter."

For the prize of £50 eighteen essays were submitted and in accordance with the unanimous recommendation of the judges, the Council has awarded it to Mr. P. S. Atkins, Second Officer, T.S.S. *Sarpedon*, Blue Funnel Line.

The Council have again offered the following prizes to the best students of Navigation in the schools mentioned below for the year 1928-9:—

Three prizes of £10 each to the Nautical College, Pangbourne; *Conway*, Birkenhead; *Worcester*, Greenhithe.

Four prizes of £5 each to *Arethusa*, London; *Warspite*, London; *Indefatigable*, London; *Mercury*, Southampton.

In order to stimulate further the study of navigation, the Council last year offered a Thomas Gray Memorial Prize of £30 to be competed for by the best students of the Nautical College, Pangbourne, the *Conway* and the *Worcester*.

The prize was awarded to Cadet-Captain John Herbert Chalk, of the Nautical College, Pangbourne, and Honourable Mention was accorded to P. Beeham (T.S. *Worcester*), C. D. Callieu (T.S. *Worcester*) and H. G. Tracey (Nautical College, Pangbourne). The prize was presented at the Nautical College, Pangbourne, in July last, by Captain Sir Arthur Clarke, K.B.E., Chairman of the Thomas Gray Memorial Trust Committee.

As soon as the fund permits, a scholarship of £25 per annum, to be held for two or three years, will be offered in rotation to the above mentioned three training schools.

XII.—Annual Competition of Industrial Designs.

The sixth Annual Competition of Industrial Designs will be held at the Imperial Institute in July, by kind permission of the Director.

The competition is again being held in the following sections:—(1) Architectural Decoration; (2) Textiles; (3) Furniture; (4) Book Production; (5) Pottery and Glass; and (6) Advertising (Posters, Show-cards, etc.). The total value of the prizes offered in all the sections amounts to over £2,000. A number of well-known firms have again offered very substantial prizes for designs in various sections.

It has always been the aim of the Council and of the various committees appointed by them to carry out this competition to ensure that any designs approved by them should bear evidence that the designers possess not only exceptional artistic ability, but also a sound and practical knowledge of the materials and processes of their trades. The committees consist mainly of representatives of important manufacturing and commercial firms, and the judges nominated by them are careful to see that approved designs are suitable for the materials for which they are intended.

After the awards have been made, a number of selected designs will be exhibited at the Imperial Institute; probably also exhibitions will be held at suitable centres outside London, where the designs will be brought to the notice of manufacturers likely to be specially interested in them.

As soon as the judges have completed their work, it is proposed to issue, as formerly, a full report on the Competition, which will be published in the *Journal*, and circulated widely among manufacturers and competitors.

The Council have opened a Bureau of Information at which are kept the names and addresses of those candidates at the Annual Competition of Industrial Designs whose work has been accepted for exhibition and who desire to obtain employment as designers. Although no guarantee of employment can be given, the information is placed at the service of manufacturers in search of designers. A number of appointments have been made in this way, and a good many designs have been sold at the exhibitions

XIII.—Examinations.

The Society's examinations are now held regularly at Easter, Whitsuntide and in July, while special sets of group examinations are conducted, at the request of the London County Council for L.C.C. Junior Commercial and Junior Technical Institutes, and a further set of examinations is held for students at Day Schools. The total number of entries this year is 105,676, an increase of about 5,000, as compared with the total for last year. A full report on the Examinations will, as usual, be published in the *Journal* at a later date.

The liberality of the Worshipful Company of Clothworkers has enabled the Council, as in past years, to offer the usual silver and bronze medals. These medals are greatly valued by the successful candidates, and they contribute not a little to maintain the high standard of the examinations.

XIV.—Oral Examinations in Modern Languages.

The Oral Examinations are still in progress in various parts of the country. Particulars will be given in the annual report on the Examinations.

XV.—New Council.

The Vice-Presidents retiring under the ordinary regulations are: Sir Charles Stuart Bayley, Sir John Cadman, Sir Alexander Gibb, Sir Francis G. Ogilvie, and Professor John Millar Thomson. In their places the Council recommend Sir Otto Beit, Sir George Marjoribanks, Sir Charles Wakefield (none of whom have served on the Council in any capacity during the current year), Captain Sir Arthur Clarke and Sir Reginald A. Mant.

The Ordinary Members of Council retiring under the regulations are: the Rt. Hon. George N. Barnes, Captain Sir Arthur Clarke, Sir Reginald Mant and Mr. W. J. U. Woolcock. In their places the Council recommend Mr.

Alfred Carpmael, Sir David T. Chadwick, Col. Sir Henry McMahon and Mr. John A. Milne, none of whom have served on the Council in any capacity during the current year.

XVI.—Obituary.

The Society has lost a number of distinguished Fellows during the year.

Lord Rosebery was a Fellow of the Society for fifty-three years, and served for two periods as a Vice-President and Member of the Council.

Sir Henry Trueman Wood was Secretary of the Society for thirty-eight years. On his retirement in 1917 he was elected a member of the Council, and served as Chairman in 1919-20. In recognition of his services to the Society he was nominated a Vice-President by H.R.H. the President.

Sir Charles Herbert Theophilus Metcalfe was a well-known engineer, who was responsible for carrying out much important railway work in Africa. He was a Fellow of the Society for nearly 40 years, and was a valuable member of the Dominions and Colonies Section.

Sir Charles Macara was for many years a leading figure in the cotton industry.

H.H. Prince John of Liechtenstein, was elected a Life Fellow of the Society in 1892.

Alderman Cedric Chivers, who died during his sixth year of office as Mayor of Bath, had established an international reputation as a book-binder, and had a factory in Brooklyn as well as in Bath.

Mr. Thomas Brough was chief designer to Messrs. Courtaulds, Ltd. He recently read a paper on "Artificial Silk," for which he received the Society's Silver Medal.

Mr. Thomas Holmes Blakesley, in addition to being a distinguished engineer, conducted a number of important researches in physical science, especially optics and electricity. At the time of his death he had been a Fellow of the Society for exactly fifty years.

Mr. C. W. Darley, after carrying out a great deal of work in connexion with railways, harbours and water supply in New South Wales, was appointed consulting engineer in London to the N.S.W. Government.

Mr. Trevor B. Simon, a well-known mining engineer of Pittsburgh, U.S.A., was president of the C.L. Miller Company, and rendered valuable service during the war in the United State Army Ordnance Department.

Obituary notices of these and some other Fellows have appeared in the columns of the *Journal*.

XVII.—Finance.

The Financial Statement for 1928, published in accordance with Section 25 of the Society's Bye-Laws in the *Journal* of June 21st, shows that the excess of expenditure over income for the year was £463 7s. The item, "Superannuation Fund . . . . £524 8s." appears for the first time in this statement.

The Society's House was purchased in 1922. The price paid was £42,000 ; alterations, repairs, furniture, architects' fees, legal expenses, interest on overdraft, etc., amounted to £8,392 16s. 7d., making a total of £50,392 16s. 7d. Towards this £43,506 13s. 2d. has been received in donations from Fellows of the Society and others, leaving a deficit of £6,886 3s. 5d.

For the years since the House was purchased the annual Financial Statements have shown surpluses or deficits as follows :—

	Surplus. £	s.	d.	*Deficit.* £	s.	d.
1922	596	17	4			
1923	1,383	13	8			
1924	974	4	7			
1925	154	16	3			
1926	828	15	9			
1927				570	5	8
1928				463	7	0
	£3,938	7	7	£1,033	12	8

The total difference between the surpluses and deficits for these years is £2,904 14s. 11d. which has been placed to the credit of the Premises Account. When this is deducted there is still a deficit of £3,981 8s. 6d. The Council are extremely anxious that this amount should be raised, and they appeal once more to the Fellows to contribute to the Building Fund in order that they may carry on the work of the Society unhampered by financial anxieties.

The Chairman, in moving the adoption of the Report, said that the outstanding new matter in the Report was the Preservation of Ancient Cottages, in connexion with which the Council had been very busy during the year. Another matter that was new was the question of pensions for the Officers of the Society. The Society was very largely indebted to Sir Thomas Holland for seeing that matter through during his Chairmanship of the Council. He would take this opportunity of saying how glad the Council was to know that Sir Thomas had been appointed to the high office of Principal and Vice-Chancellor of the University of Edinburgh.

Lord Askwith, K.C.B., K.C., D.C.L., in seconding the adoption of the Report, said that mention was made in the Report that the Society had placed its offices and staff at the service of the Fund for the Preservation of Ancient Cottages, without any charge, and thus the Fund had been entirely free from rent and secretarial salaries. This was a great assistance rendered by the Society for the Fund.

The Report was unanimously adopted.

The new List of Council, having been suspended in the Library in accordance with the Bye-Laws, and no additional nominations having been made, the CHAIRMAN declared that the following were elected to fill the several offices. (The names in italics are of those Fellows who have not, during the past year, filled the office to which they have been elected) :—

PRESIDENT.

H.R.H. The Duke of Connaught and Strathearn, K.G.

VICE-PRESIDENTS.

*Lord Askwith, K.C.B., K.C., D.C.L.
Llewelyn B. Atkinson, M.I.E.E.
Sir Otto Beit, K.C.M.G.
Lord Bledisloe, P.C., K.B.E.
Captain Sir Arthur Clarke, K.B.E.
*Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.
Sir William Henry Davison, K.B.E., D.L., M.P.
Peter MacIntyre Evans, M.A., LL.D.
Sir Edward Gait, K.C.S.I., C.I.E.
Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.
Rear Admiral James de Courcy Hamilton, M.V.O.
John S. Highfield, M.Inst.C.E., M.I.E.E.
Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
P. Morley Horder, F.S.A.
Sir Herbert Jackson, K.B.E., F.R.S.
Major Sir Humphrey Leggett, D.S.O., R.E.
Sir Philip Magnus, Bt.
Sir Reginald A. Mant, K.C.I.E., C.S.I.
Sir George Marjoribanks, K.C.V.O.
*Hon. Sir Charles A. Parsons, O.M., K.C.B., LL.D., D.Sc., F.R.S.
*Alan A. Campbell Swinton, F.R.S.
Sir Charles C. Wakefield, Bt., C.M.G.
Sir Frank Warner, K.B.E.
Sir Alfred Yarrow, Bt., F.R.S.

ORDINARY MEMBERS OF COUNCIL.

Alfred Carpmael.
Sir D. T. Chadwick, C.S.I., C.I.E.
Sir Atul C. Chatterjee, C.I.E.
Col. Sir Arthur Holbrook, K.B.E., M.P.
Col. Sir Henry McMahon, G.C.M.G., G.C.V.O.
Sir Henry A. Miers, F.R.S.
John A. Milne, C.B.E.
Sir Richard Redmayne, K.C.B.
Col. The Master of Sempill.
James Swinburne, F.R.S.

*Nominated by H.R.H. the President.

Carmichael Thomas.
Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O.

TREASURERS.

Sir Charles H. Armstrong.
Sir George Sutton, Bt.

THE CHAIRMAN then proposed a cordial vote of thanks to Mr. G. K. Menzies (the Secretary), Mr. W. Perry (the Assistant-Secretary and Secretary of the Indian and Dominions and Colonies Sections), Mr. J. H. Buchanan (the Accountant and Examinations Officer), Mr. C. D. Cassidy (the Librarian), Mr. H. J. Dack (the Chief Clerk), and to the other Officers of the Society, for their services during the year.

The motion was duly seconded, and the vote of thanks carried unanimously.

THE SECRETARY said that he felt sure that the Society would like to record their thanks to the Honorary Solicitors of the Society, Messrs. Bristows, Cooke and Carpmael. They became Honorary Solicitors to the Society about two years ago, and since then had done an enormous amount of work, especially in connexion with the Preservation of West Wycombe. The Society would certainly have incurred heavy legal expenses, both in that and the matter of Arlington Row, Bibury, without the help of the Honorary Solicitors.

THE CHAIRMAN thereupon proposed a vote of thanks to the Honorary Solicitors and the motion was carried unanimously.

SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., in proposing a vote of thanks to the Chairman, said that Sir George Sutton had not, he thought, missed a meeting and had presided in his official capacity not only at the Council, but at many of the Committees, and especially the Examinations Committee, which had done so much valuable work for the Society. It had already been mentioned that the examination entries had now touched 105,000 as the total for the year. That figure was a record for the Society, and it probably put us in the uncomfortable position of being the largest examining body in the world. Sir George Sutton had been very active as the Deputy Chairman of the Committee. It was even more gratifying to the Council, as they regarded him as one of the products of their Examinations. Very many years ago he passed his first examination at the Royal Society of Arts, and the Council hoped that Sir George's example would serve as a stimulus for all young students.

The motion having been duly seconded, the vote of thanks was carried unanimously.

THE CHAIRMAN, in acknowledging the vote of thanks, thanked Sir Thomas Holland for the kind remarks he had made. The year's work had been exceedingly pleasant, and he had never had anything to do in an honorary way which had given him more pleasure than presiding at the meetings of the Council of the Royal Society of Arts. The business had been interesting, but there had been a good deal of it. As this would be the last meeting he would attend as Chairman, he would like to emphasise that a Society like this, that had to depend on men who were very active in the world, must be very careful that it did not take upon itself too much work so that people would fight shy if asked to serve. This was a scientific Society, promoted for the encouragement of Arts, Manufactures and Commerce, and had existed for a century and three quarters, and to keep the Society strong and let it live for another century and three quarters it wanted good men to take an interest in the work. The members of the Council were giving the time now, and he admired the splendid meetings of the Council which had taken place during the past year. The Council Room had been crowded out month after month, which was a great tribute to the zeal with which members of the Council discharged their task. Some of them gave a great deal of attention to the work of the Society. In particular, Mr. Morley Horder, Chairman of the Fund for the Preservation of Ancient Cottages, had shown the greatest enthusiasm and had devoted much time and professional assistance to the cause.

NOTES ON BOOKS

DOMESTIC ARCHITECTURE AND OLD FURNITURE. By Murray Adams-Acton, F.S.A. London: Geoffrey Bles. £2 2s. net.

This sumptuous and agreeable book, with its wealth of illustrations, celebrates the living past. As the author reminds us in his preface—not in these words—all old things are not in museums. Whole towns are standing, built in the distant past, that are inhabited, full of animation, practically untouched by the architects of the twentieth century. There is Bath, there is Bamberg, there is a host of delicious little provincial centres in Europe—as well as a few at home—where the atmosphere of more restful ages can be recaptured and enjoyed. The happy man of leisure and taste can take his choice: Bavaria alone offers him the middle ages and the eighteenth century, and a chain of Baroque cities stretches across Europe from Trier to Cracow. I am told that Vicenza is a coherent and organic whole, and one gathers from Mr. Adams-Acton that Verneuil is off the arterial highway of modern progress. And it is not only the houses that are intact: so are their frescoes, and so, very often, is their furniture. The framework of the ancient world has not yet been destroyed; barons and squires still live in the castles and manors and among the heirlooms of their ancestors.

The nineteenth century, from the artistic point of view so relatively barren, and the twentieth century, still so young and raw, offer little material for study by the lover of beautiful things compared with what earlier times can show. There is, Mr. Adams-Acton tells us, a considerable vogue in America for early Victorian furniture, but what is it beside the vogue for Chippendale or Louis Quinze?

This book is a sort of history of art, written not in the manner of a text-book but like something between an essay and the report of a series of lectures ; it is genial, very readable, here and there provocative, always interesting. The examples selected for comment are splendid, and the publisher has done justice both to them and the letterpress. What better instance of fifteenth century Flemish metal-work could Mr. Adams-Acton have chosen than the immortal chandelier in Van Eyck's portrait of Arnolfini and his wife ? This photograph would amaze, if one were not prepared for any miracle from the picture. A second painting included most aptly among the illustrations is Dierick Bouts's "Last Supper," which shows a Gothic interior : wooden ceiling with oak beams, pointed-arched doors and windows, tiled floor, and a curious recessed sideboard. One could join issue with Mr. Adams-Acton on the subject of Gothic, of which he is a devotee ; he admits, however, that "there is always more or less of a monastic air about a Gothic interior." Is it not a sign of superiority in classical and renaissance architecture that its principles and features are applicable to every sort of building without there being a serious danger of making everything look like a Greek temple ?

Mr. Adams-Acton is shrewd and amusing about Rococo. "Owing," he says, "to the fact that the great majority of people in England were unfamiliar with examples of what I consider a very beautiful period of architecture, a prejudice against any form of its characteristic decoration was established in this country." He goes on : "This insular failure I ascribe to the fact that all kinds of decorative travesties, libellously labelled 'Louis Quinze,' to favour an illusion of genteel gaiety, were designed to adorn restaurants and similar places." Yes : one knows the kind of "frolicking females in Pompadour attire" of whom he writes ; before the modern movement gathered force they were often to be seen on the panels of cinema *foyers*, attended by Lancretesque serenaders

The author's remarks about the civic architecture of to-day in England are just. For "the tyrannical use of straight lines and cubist forms" he ventures to predict "but a short existence." Here his faith is the offspring of hope. May it not be from some modified, humanised architecture of this sort, which is at least not pseudo-anything, that a genuine style shall spring, able "to express the best artistic talent of the country" ?

Mr. Adams-Acton expresses what so many of us feel about Ye Olde Tea-Room, with its oak-panelling and antique chimney-piece More up-to-date effects are often bungled : "why do some people invariably hang electrical fittings just as near to the ceiling as they possibly can ? . . . They . . . provoke a fear that to read a book at night it would be necessary to sit on the top step of a ladder."

At the end of the book we find a chapter on spurious furniture, of special interest to the dealer and collector. It is well illustrated with photos of genuine and faked worm-holes.

In short, *Domestic Architecture and Old Furniture* would be a lovely present to get—either from a friend or from oneself.

AMERICAN FURNITURE AND DECORATION. COLONIAL AND FEDER By S. Holloway. London : J. B. LIPPINCOTT COMPANY. 21s.

A short time ago there appeared an amusing book by an American cartoonist entitled : "The Prince of Wales and other Famous Americans." Mr. Holloway's excellent book might have been called : "Chippendale and other notable American Styles." For, as the author hastens to inform anyone who may not have been

aware of it, or who finds it difficult to bear in mind: "Until the Revolution we were all Englishmen." Nor did a new American art spring up directly that Revolution was over. The genius of the people that has in a century and a half become so rich and powerful lay in another quarter. Nature has been so generous to them that they have needed the consolations of art less urgently than Europeans.

But whatever may be thought of native American culture, one cannot deny the interest, both intelligent and generous, that Americans have long taken in culture as materialised outside their own land. Not all their millionaires allow faked antiques to be thrust on them, certainly not those who have gone to school with Mr. Holloway. But, of course, there is a good deal to be said for faked antiques, provided no lies are told about their origin, and after all, in copying European models, the American cabinet makers have only shown their good taste

In the main, the great European styles had their counterpart in America, always, as was natural, after a certain interval after their inception. American Jacobean begins the tale, though no bedsteads of the time survive. Beautiful chests can be seen in the Metropolitan Museum that are known to have been made in the country.

The William and Mary period brings us to one of the developments that are claimed as genuinely American. This is the banister-backed chair. "The example illustrated in Plate 6 B preserves the baluster-turning of legs and arm-supports of the Stuart years, but the feet and modified bulbs of the stretcher place it with William and Mary furniture."

A modification of Chippendale as applied to desks is also considered to be an American, more particularly a New England, development. Mr. Holloway traces the block-fronted desk to Dutch as well as English ancestors, and shows an early Dutch-Colonial desk from Ceylon that may well be a prototype of its vis-à-vis on Plate 28. More often the best American work would be taken for English but for the wood used; the Chippendale secretaire, Plate 32, being finished with American pine, thus allows no dispute as to its origin.

The short tale of American innovations is brought to an end with the bedsteads of the first quarter of the nineteenth century that had acanthus-carved posts. The effect of these, as shown on Plate 122, is not altogether pleasing; Mr. Holloway says they are "handsome though heavy" Certain combinations of European details are also American; they may be claimed with the more assurance in view of some of them having come to Europe from the East in the first place.

In America, as in England, the French Directoire and Empire styles had their vogue. An elegant Directoire chair on Plate 95 has a carved American eagle; very fine, too, are the Philadelphian chairs shown on Plate 99. We come across no American Chippendale or Riesener, yet it is clear that the American cabinet-makers, working, as Mr. Holloway says, not under the influence of so much as in the style of the eminent Europeans, were men of taste and ability. The backgrounds for their work were borrowed from Europe, too; not till the coming of the skyscraper did American architecture show its independence. But American architects still study at the Ecole des Beaux Arts, and the most modern furniture in the United States is on the whole based on French designs.

From the beginning Americans have been great readers of books. Every important furniture text-book has had close attention paid to it on the other side of the Atlantic, and I have no doubt that Mr. Holloway's handbook will receive the study it deserves. The paper, type, and illustrations could not be better for their purpose.

P.B.

HANDCRAFT IN WOOD AND METAL. By J. Hooper and A. J. Shirley. London: B. T. Batsford, Ltd. 10*s*. 6*d*. net.

The handcrafts are not as moribund in England as may be feared. A recent series of articles in the *Times*, describing various local industries of the craft order, drew attention to what is being done in the different counties. The two blacksmiths in my village are ironworkers of no little skill. They turn out excellent hinges, fire-irons and candle brackets. So, it appears, do the forges in other parts of Kent. To my knowledge, also, a neighbouring carpenter has carried out some designs for corner cupboards and other furniture with a good deal of taste. He is certainly not an isolated case.

Messrs. Hooper and Shirley's text book, here in its third edition, is perhaps more utilitarian than inspiring. That is, we may be taught by it to use our tools correctly, but we shall be a little alarmed by the sad results which may be achieved by a punctilious observance of the rules laid down for our guidance. Take the frontispiece. It would be most disagreeable to have to spend even a few hours in a house ornamented with such skilful and vapid samples of the craftsman's art. The platter is not offensive, but the inlaid mirror has no æsthetic value whatever and the candlestick is vulgar. England is now strewn with tea-houses where this type of craftwork can be studied *ad nauseam*.

It is too easily assumed that somehow or other "art" will tread inevitably on the heels of "craft," as "love" is said to come with time into marriages of convenience. Art is actually more shy of ingenuity than of anything. Ingenuity has a way of posing as an end in itself, and for ingenuity, for the "gadget", our age has a passion. Describing a station restaurant, Roger Fry wrote: "In the centre of each table is a large pot in which every beautiful quality in the material and making of pots has been carefully obliterated by methods each of which implies profound scientific knowledge and great inventive talent." It does not need machinery to produce these devastating effects. Handcraft unilluminated by taste is every whit as bad. It is a question, too, whether no taste at all or bad taste is the worse. We can sometimes put up cheerfully with a medley of decorations, good and bad; but a room complete from end to end with calculated minor horrors—no.

Still it is only by trying that we can hope to bring about a *rapprochement* between art and necessity. Our misfortune is our forebears allowed an estrangement to come about. To-day craftsmanship savours of the "hobby" and suggests feeble amateurishness. It seems incredible that the greatest race of artists the world has known came out of the booths of craftsmen; yet was it so. This recollection may hearten the student depressed by the weakness of the models held up to him.

Messrs. Hooper and Shirley have done their best to direct their readers to models capable of inspiring. There have been craftsmen of talent from remote antiquity, and we may be sure that as often as not the atmosphere in which they worked was not specially friendly to refinements of art; there were philistines before the accession of Victoria. Set against the frontispiece the magnificent doorway by the brothers Adam, of which there is a photograph on page 110. Here the separate parts are beautiful, most beautiful in their subordination to whole. The "purpose" for which they are "fitted" is an æsthetic one; the portico would have been no less secure against the elements if a bad craftsman had been let loose on it.

A good deal may be learnt from "Handcraft in Wood and Metal," but its influence would be better if its space and its praise were less indiscriminately apportioned between experimental stuff and masterpieces. P.B.

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FRIDAY, JULY 12th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

PRESENTATION OF THE SOCIETY'S ALBERT MEDAL TO SIR ALFRED EWING.

The Council of the Royal Society of Arts attended at Clarence House on July 2nd, when H.R.H the Duke of Connaught, K.G., President of the Society, presented the Albert Medal for 1929 to Principal Sir J. Alfred Ewing, K.C.B., LL.D , D Sc., F.R.S., " for his work in magnetism and his services to technical education." Lt -Col. G C Douglas Gordon, C.V.O., D S.O., was in attendance upon His Royal Highness.

The members of the Council present were:—Sir George Sutton, Bt. (Chairman); Mr. Llewelyn B. Atkinson; Sir David Chadwick, C.S.I., C.I.E.; Mr. P. M. Evans; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.; Major Sir Humphrey Leggett, D.S.O.; Sir Philip Magnus, Bt; Professor John Millar Thomson, F.R.S.; Mr. J. A. Milne, C.B.E.; Sir Richard Redmayne, K.C.B.; Mr. Carmichael Thomas, and Lt.-Col. Sir Arnold T. Wilson, K.C.I.E., C.S.I., D.S.O., with Mr. G. K. Menzies (Secretary) and Mr W. Perry (Assistant Secretary).

PROCEEDINGS OF THE SOCIETY

INDIAN SECTION.

SIR GEORGE BIRDWOOD MEMORIAL LECTURE.

FRIDAY, MAY 10TH, 1929.

SIR E. DENISON ROSS, C.I.E., Ph.D., in the Chair.

THE CHAIRMAN, in introducing the lecturer, said Captain Johnston-Saint was not a doctor. He had, however, spent six years in India, and was first and foremost a historian. For many years he had been connected with the wonderful Wellcome Historical Museum of Medicine, and had had opportunities of making investigations into the resources and history of medical practice and medical instruments, not only in England but on the Continent and in the East.

The following lecture was then delivered: –

AN OUTLINE OF THE HISTORY OF MEDICINE IN INDIA.

By CAPTAIN P. JOHNSTON-SAINT, M.A. (Cantab), F.R.S. (Edin.), I.A. (retd), of the Wellcome Historical Medical Museum.

In the year 1645, Dr. Gabriel Boughton, who was surgeon of the *Hopewell*, successfully treated several members of the household of the Emperor Shah Jehan, and in the following year he also treated the Governor of Bengal For these services Boughton was asked to name his own reward, but he replied that he wished for nothing except that his countrymen might be granted a maritime settlement in Bengal. Shah Jehan granted him a firman which enabled a factory to be opened at Hugli and a settlement at Balasore. The latter was fortified and consequently became the key of the position which the British have since acquired.

We observe then that this foundation stone of British power in India was laid, not by fire and the sword, but by that bond of sympathy and understanding which is associated with medicine wherever it is practised.

In those days of course, and for long after, we Europeans held in the lowest esteem every pretension of the East to any real knowledge at all. The many and varied races of immemorial India we thought fit to lump together as "barbarians," and our earliest doctors to go out there wrote, when they wrote at all, of Indian medicine as a matter of childish charms and philtres, almost a sort of Voodoo devil dancing.[1]

A few inexplicable tricks the natives might have, but in the main their arts were but superstitious nonsense as compared to the blazing light of Western science.

Of the point of view of the Indian doctor faced by this foreign superiority we need now say little; it may suffice to notice that for generations after the first European invasion a malady became known to the Hindu doctor as "Portuguese Disease."[2] It was the contribution of Western enlightenment to the darkness of the benighted East.

EARLY WESTERN IGNORANCE OF INDIAN HISTORY.

For well over two hundred years this remarkable ignorance obtained, and as late as Victorian times professedly well informed scholars were writing that Europe owed nothing to India, stressing the point indeed, in at least one case, by referring to the Hindus as "Mongols,"[3] an ignorance and indifference which appear extraordinary in a nation which has so close a connection with that vast country. Indian history in fact we practically said began with the

[1] *Quarterly Journal Calcutta Med Soc* 1837, i, p. 124.

[2] Jee. *History of Aryan Med. Science*, p. 38, and Bhava Mishra Bhavaprakasha.

[3] *British and Foreign Med Review* 1847, xxiii, p. 521.

English domination and before this was but a farrago of myths and legends [4] All Indian science was but a superstition, all its medicine but a matter of spells and charms. And this from English doctors who up to our own living memory were beginning their prescriptions with a traditional scrawl of the pious invocation "Jupiter be propitious to us!" It was indeed a literal case of the mote in our neighbour's eye.

In 1762 an epidemic of fever was ravaging India and a European doctor notes the death of thirty thousand natives in a single day; this exceptional mortality he explains was due to an eclipse,[5] while other practitioners of his day were writing learned little notes on the effect of the tides of the sea upon the pregnancy of women Be very sure that all these gentlemen were deservedly severe upon the absurd superstitions of Hindu so-called medicine.

The Causes of our Early Ignorance.

Humiliating as it is for us to have to admit an ignorance at once so extraordinary and so self sufficient, at least our ancestors have a certain amount of excuse, and generally speaking it may be classed into three main groups.

In the first place Sanskrit treatises on medicine had been hitherto little noticed by Sanskrit scholars. The subject was not of general interest, and to translate these treatises in any useful manner would necessitate the translator being not only a perfect Sanskrit scholar but a physician as well. Further, the Hindu himself has a poor sense of history as we understand the word Art, he says in effect, possesses no Ancient or Modern, and personalities have a poorer place than amongst ourselves. While to "William the Conqueror" every English child repeats the date 1066, in India it would be "Once upon a time there was a great King." This lack of attention to Sanskrit literature and the absence of discrimination in the historical sense may perhaps be regarded as the primary reason for our early failure to realise the existence of any medical history in India.

In the second place our system of classical education had already given us an apparent beginning for all the arts and sciences. A disproportionate part of our education was devoted to ancient Rome and Greece where we learnt all about Apollo and Aesculapius and in Greek history we came to Hippocrates. Here we had got a founder of medicine all ready for us, and that there might have been any one before him few of us were disposed to inquire. Certainly with all this good classical knowledge, so laboriously acquired, we were not prepared to venture still further afield, and most assuredly not into the and clouds of the story of a land which we universally regarded as both black and barbaric; so there we have reason number two for our appalling ignorance.

[4] Eliot. *Hinduism and Buddhism*, i. p. xcvi.

[5] *Quarterly Journal Calcutta Med. Soc.* 1837, i, pp. 124-156.

The third reason which brings us to the main thesis of our lecture is that about the time of the first European introduction to India, medical science in that country had fallen to perhaps the lowest point in the curve in all its long history, and so vast is the scope of this subject that it is only the fringe of it that I dare attempt roughly to trace.

THE DAWN OF HISTORY.

Into the question of the dates of the beginnings of Indian civilization this is not the place to go, for the truth is that with all our speculation we do not know anything definite. It was only some 120 years ago that we of the West first began to apply ourselves to the study of Sanskrit, and though since then whole libraries have been written upon the problems of Aryan beginnings, we cannot yet be satisfied that we have reached a definite establishment of truth. Some there are who say that the great Aryan race had its birth-place amid the recesses of Central Asia, others hold on the other hand that it is rather to Scandinavia or North Germany that we should look for its origin.[6]

We used to be satisfied that the oldest Vedas dated back to perhaps 2000 B.C. Whitney, Grassmann and Bentey provisionally assume 2000 B.C. as the starting point of Hindu literature. Brunnhofer has suggested 2800 B.C., Prof. Jacobi of Bonn supposes the period to go back to 4000 B.C., while according to one school it may be that we should date them back to some even more remote glacial age when the very world itself was not the earth we know to-day. The Avesta, they say, points to an Aryan paradise that can only have been the North Pole, a region removed by tens of centuries from anything of which to-day we can have the least conception.[7]

THE MYTHOLOGY OF MEDICINE IN INDIA.

However all this may be—and the issues raised are too vast for any discussion of an hour or so—we can but take the Vedic hymns as we find what remnants are left of them, setting them down as of immemorial antiquity. Whether the Rig Veda and the rest date from 1500 B.C., from 2500 B.C., from 4500 B.C., or from some dateless age even further back still, for present purposes is not our concern. Let us simply take the story as we find it, a story as plain as that of the school boy's Homer, without going into elaborate speculations as to who Homer may have been and when, and in the examination of this old story, we must remember that the value of mythology as a contribution to the study of ancient history is highly important. The philologist studies legends in order to fill the gaps in broken epigraphic compositions; the historian uses them to push back to their sources and to find a base whence he may move forward in search of reality. And so we find then that the Self-create

[6] Whitney, *Oriental and Linguistic Studies*, i, and Müller, *Ancient Sanscrit Literature*, pp. iv-vii.

[7] Tilak, *Arctic Home in the Vedas*, xiii, p. 414 et seq.

Brahma, having for the guidance of the universe written the Four Vedas and amongst them the Atharva Veda, communicated them to other gods, the two Aswins or sons of the Sun becoming the particular custodians of the Atharva Veda and thus the medical attendants so to speak of the hierarchy of heaven.

Next came the Upvedas or supplementary hymns designed for the more detailed instruction of mankind, and of these Brahma, taking compassion on man's sick, degenerate and suffering state, produced the Ayur-Veda which contained a treatise of the science of life.

The hymn itself in its entirety has perished and we know it but by fragments and comments in later Indian literature, but even from this second hand repute we are assured that for untold ages it was this Ayur-Veda that was regarded as the very foundation stone of Hindu medical science.

Then at some later period, after the deluge, the Vedas were lost and the plight of mankind became once more a sad and suffering one. Then the gods and demons, in order to recover the lost knowledge for the relief of the sufferings of mankind, having collected plants and herbs of divers kinds, cast them into the sea; they took Mandara the mountain as a churning stick: the god Vishnu, the second of the Hindu triad, assuming the form of a tortoise became the pivot upon which the stick turned; Shisha the serpent served as a cord and the gods on one side and the demons on the other alternately pulling on the serpent, churned the ocean until the fourteen gems or rātanas, rose from the depths amongst which was Dhanwantari the god's physician and the Vedic father of medicine, with the cup of life-giving draught, Amrita, the beverage of immortality.

Dhanwantari, the Aesculapius of India, came to earth to minister to the misery and disease of mankind and to instruct them in the science of life. Unlike his brother Aesculapius, the Greek, he has not an attendant serpent, but is generally represented as a venerable old man with a book in his hand. The sages sent a deputation to Dhanwantari requesting him to teach them the science of life and amongst the deputation was Susruta, the founder of Hindu surgery, whom Dhanwantari selected to teach the Ayur-Veda and who subsequently wrote a famous book on surgery called the "Susruta Samhita."

As Susruta was the father of Hindu surgery, so Charaka, who also wrote a famous book on the science of physic entitled "Charaka Samhita," was the father of Hindu medicine. Susruta was essentially a surgeon and Charaka a physician and it is from these two teachers that the Hindus obtained their science of surgery and medicine in the years to follow after.

The Beginnings of Authentic Medical History.

We cannot say with any degree of certainty whether Charaka or Susruta was the earlier; from the point of view of literature the writings of Charaka

FIG. 1.—The Churning of the Ocean, or 2nd Awatar of Vishnu Dhanwantari, the Vedic Father of Medicine, the eighth of the fourteen Gems or Ratanas, appears on the left, facing the white shell.

(Copyright Wellcome Historical Medical Museum)

FIG. 2.—Dhanwantari, the Vedic Father of Medicine, holding the bowl of Amrita, or water of immortality.

(Copyright Wellcome Historical Medical Museum)

would appear to be of an earlier style,[8] but among the ancients it seems to have been almost an axiom that surgery comes before medicine. Dr Wise in his "Hindu Medicine" says, "Dhanwantari asked his pupils "On what shall I first lecture?" They answered "On surgery," because formerly there were no diseases among the gods and wounds were the first injuries which required treatment. Besides, the practice of surgery is more respected as affording immediate relief and is connected with the practice of medicine although the latter has no connection with surgery ""[9] Surgery was the first requirement, illness only came later to a fallen mankind, being in fact a retribution for its own sins.

On these and other grounds it may well have been that Susruta preceded Charaka, but which of the two came first or whatever their precise dates may be, it is certain that their particular schools of science were early enough to have been known and appreciated by other nations. The Arabians for instance quoted them, and in turn were quoted by the Roman doctors. We later arrive at the "Indi dixunt" pointed out first by Professor Dietz in his "Proofs of the Antiquity of Hindu Medicine" We have then at some rather indefinite but undoubtedly very early date a Susruta as the father of Indian surgery and a Charaka as the father of Indian medicine.

[8] Bhishagratna. *Susruta Samhita*, 1, p xi

[9] Wise *Commentary on the Hindu System of Medicine*, p. 7.

And so we have the foundations of Hindu Medical Science in these two codes, to which we might presently add a third in the treatise called the Nidān or diagnosis, each of them in turn based upon the Ayur-Veda and quoting liberally from it and amplified in the Brahmana, or commentaries of the period one may term the Hindu Middle Ages.

Divisions of the Ayur-Veda.

The Ayur Veda itself as we know it from its commentators seems to have been divided into eight parts, two treating of surgery, five of some branch or other of medicine and one of what was in later ages generally known as the Elixir of Life. The first dealt with the surgery of the removal of foreign bodies, of healing knife wounds, of bandages, blisters, and the proper treatment of inflammations and abscesses.

The second surgical chapter is concerned with the external organic affections of eyes, ears, mouth and nose. The third chapter, or the first medical section, has to do with diseases affecting the whole body, such as fevers and the like.

The fourth chapter is on ailments of the mind, the fifth has to do with the care of infants; the sixth with the administration of antidotes, the seventh with the medicines for restoring youth, and the eighth deals with how the increase of the human race could best be promoted.

"Chemistry" it is true may have been an Arabic word, but the science itself appears in India long before the time of the Arab scholars,[10] for the seventh chapter of the Ayur-Veda treats exhaustively of this science.

These eight divisions of the Ayur-Veda are more or less followed in sequence by Susruta and Charaka.

Susruta

Susruta, according to the Hindus, was the son of Vishvamitra a contemporary of Rama. Precisely when he may have lived we do not know, Sir William Jones places the subjugation of India by Rama about the year 2000 B.C. On the other hand some philosophic scholars assert Susruta to be a contemporary of the Buddha. As many Vedic hymns are ascribed to him it follows that he must have flourished during the Vedic Age. Again in the tenth book of the Atharva-Veda there is a hymn on the creation of man in which the skeleton is described according to Atreya and Susruta.[11] A large portion of the Atharva-Veda admittedly belongs to a period as early as 1000 B.C. and the hymn in question is included in the older portion.[12] This would appear to warrant the assumption that Susruta could not have flourished later than 1000 B.C. Nor have we got his original text; the Sanskrit version of what we call Susruta being

[10] Wise. *History of Medicine*, i, p. xli.

[11] *Journal of the Royal Asiatic Soc.* 1906, p. 915, and 1907, p. 1.

[12] Hoernle. *Med. of Ancient India.* Part 1, p. 9.

really a recension of recensions made at some considerable period after the date of the original.

Under his "code," to use a convenient even though not altogether accurate term, the eight books of the Ayur-Veda fall under six main headings. It is the two surgical chapters of the Vedas with which he chiefly deals, though as is common even to-day the surgeon also treats to some extent of medical ailments. The first of the six chapters is all surgery proper, but includes observations on climate and on food as affecting health. The second chapter deals with ailments brought about by vitiated humours; his third we might roughly translate as anatomy, his fourth as therapeutics, his fifth as toxicology and his sixth and last is supplementary, dealing with various local diseases.

It is, however, surgery in which Susruta specializes, calling it "the first and best of the medical sciences, less liable than any other to the fallacy of conjectural and inferential practice, pure in itself, the worthy product of heaven and certain source of fame." The irreverent layman would seem here to see the distinct forerunner of western theories.

CHARAKA.

Very much the same considerations are to be drawn from the study of Charaka; who precisely he was and exactly when he lived we do not know. His "code," if we may for convenience call it so, is arranged in the form of dialogues between the master and pupil, the subjects with a certain lack of system apparently more or less suggesting themselves as they went along. A certain amount of the conversation is necessarily desultory, but its obvious object is the discussion of the subjects most pertinent to the benefit of mankind.

The first book, divided into thirty heads, deals with the origin of medicine and the duty of the physician, and here we can trace some sort of analogy to the oath of Hippocrates. The arrangements, properties and uses of medicine are each discussed and the cause, nature and prevention and cure of diseases. Diet, steam baths, the broad classification of foods—these are only a few of the subjects treated in this first book.

The second book goes on to describe diseases such as fevers, tumours, leprosy, mania and epilepsy. The third book considers the nature of epidemics, the peculiarity of the fluids of the body and other subjects. The fourth treats of conception, the variety of the species, the parts of the body and the connection between body and soul. The fifth book is a description of the organs of the senses, their peculiarities and ailments, affections of the speech, causes of diseases of organs, sudden losses of strength and death. The sixth book treats of the means of securing increased vigour and enjoying long life, and different classes of ailments are dealt with, as dropsy, jaundice, asthma, erysipelas, thirst and poisoning; inflammations, the effects of intoxication, abscesses, rheumatism and paralysis too, all find a place in this book.

The next, the seventh, treats of emetics and purgatives, and in its twelve chapters we see a remarkable number of such purgative medicines as were known to the ancient Hindus.

The last and eighth book, also in twelve chapters, deals with evacuating medicines for fevers, injections for various purposes, clysters and so forth. The arrangement to our modern ideas is often obscure, but that the sequence follows a system there is no possible doubt. With what we might call pure medicine is mixed up a good deal of mythology, and this too, helps to accentuate a certain lack of scientific system.

Notwithstanding blemishes obvious to the modern Western intelligence, the evidence of real knowledge is remarkable, and if we consider the position as regards this wonderful medical knowledge displayed at such an early date, it will, I think, appear obvious to us, that such a state could not have been attained in a day, but must have required long training and evolution, and would take these people back to the remotest antiquity. A little later on I propose to give many instances where this ancient Hindu science, under whatever term is chosen for its designation, medicine, religion or philosophy, actually antedates by centuries many a modern triumph on which present-day Western civilisation preens itself as the discoverer.

Instrumental Surgery.

From these two, Susruta and Charaka, sprang many schools and sages. Dr. Wise of the Bengal Medical Service writing in 1845 mentions two systems of Hindu surgery, nine systems of medicine, three of materia medica, one of nosology, one on pharmacy, three on metallic preparations. Of this formidable number at least four have left no recoverable trace, but from the others we can gather the strength of the scientific knowledge of the early India.

The instrumental part of surgical treatment, they said, was divided into eight branches, to wit, cutting or incising, division or excision, drawing lines which corresponded to what we call scarification, and inoculation, puncturing, probing and sounding, the extraction of solids, the extraction of fluids and venesection and lastly suturing.

For these diverse purposes the surgical instruments were divided into two classes, the Yantras or blunt instruments, and Sastras or sharp instruments. The Yantras which constitute the greater portion of the surgeon's outfit consisted of instruments such as forceps, specula, syringes, cupping appliances, probes, spoons, cauteries, etc. The Sastras consisted of knives of divers sorts for various purposes, needles, scissors and sharp probes. With these Yantras and Sastras went such appliances as thread, leaves, bandages, pledgets, and a variety of astringents and emollient applications; and these Yantras and Sastras were divided into no less than 125 separate classes. I hope in a few minutes to be able to outline some of the more striking.

Hindu Anatomy.

Before proceeding to give a more detailed description of these instruments, I wish, at the risk of apparent digression, to touch first on another point, the teaching of anatomy. From my preceding remarks it has I hope been obvious that the early Hindu surgeons must have possessed a very considerable knowledge of anatomy, and we find ourselves faced then with some difficulty in reconciling this deduction with the horror of modern India at even the touch of a corpse. When in 1836 English surgery was first introduced into India, only ten students could be found in the whole of the peninsula even to consider the prospect of dissection, and then on dry bones and on the skeletons of goats; the human body was taboo and it was not till one student– his name deserves to be remembered, Modoosoodna Gupta—managed to lead the way by conquering his prejudices that any progress at all was possible.[13] Even then the first dissecting room was specially built with high walls and was permanently under a strong police guard, so high ran local feeling Children were said to be kidnapped, the sick to be murdered for the dissecting table; even in the England of a century back we seem to have heard similar tales! How then are we to reconcile a prejudice so intense with the fact of early Hindu anatomy? The solution is that the ancient Hinduism was almost free from this feeling which grew intense with the ages In the Institutes of Manu,[14] composed probably about B.C. 1200, we find a clue to the older law, "Mere bathing" it says "will purify after the touching of a corpse, while to stroke a cow or to gaze at the sun, if the mouth be but sprinkled with water, will remove the defilement due to the touch of a dead bone." It was under this earlier and easier code that Hindu surgery rose to its full heights

The systems of anatomy fall roughly into three schools, those of Atreya who is reputed to have lived about B C 1200, of Susruta and of Vagbata who flourished about the second century B.C. While whole books could be written on the various versions and MSS. that are extant of the writings of these sages, we need only cursorily refer to the immense pains taken in their catalogues of the parts of the human body. A traditional recension of the statement of Charaka for instance begins as follows. "The body consists of the following parts, the two arms, the two legs, the head and neck, and the trunk. These made up the sexipartite body; inclusive of the teeth and nails it has 360 bones," which are then given in detail. It will be observed that Charaka looks upon the head and neck as being together but one main division.

In Susruta's table on the other hand we get a grand total of only 300 bones as he says "Surgical science knows only of 300 bones. Of these there are 106 in the extremities, 128 in the pelvic cavity, sides, back, shoulder and breast,

[13] *Glasgow Med. Journal*, 1870 71, p. 547

[14] *Institutes of Manu*, Ch V, v. 85, 87

and from the neck upwards 66. In this wise the total of the 300 bones is made up." And then he proceeds to count them in elaborate detail.

The difference between that of Susruta and Charaka is probably accounted for by the fact that Charaka counted the thirty-two teeth and the twenty nails as separate bones. But, however these doctors may have differed as to their way of reckoning, there is no room for possible doubt that their system gave them a very thorough knowledge of anatomy, as indeed must have been necessary for the performance of the operations which we know were freely undertaken, some of them of the utmost delicacy. For not only were limbs amputated, but abdominal sections were performed, fractures were set, ruptures were reduced and foreign substances were dexterously extracted.

To Susruta is due the glory of the discovery of cataract-couching, centuries before it was known to the west, while the plastic surgery of skin grafting and rhinoplasty, only comparatively lately rediscovered in Europe, were frequently practised by the same great Hindu.[15]

His rules lay down exact regulations for the operating room; it was to be fumigated with such and such disinfectant vapours, a light refreshment was to be offered to the patient before certain operations, while before other operations he was to be fasting. The surgeon should keep his hair and beard short, his nails clean and close cut—a doctrine which has been rediscovered by our modern bacteriologists—and wear a clean, sweet-smelling dress.[16] Even anæsthetics in some form or other were known, and at some later period we see in the Bhojaprabandha,[17] a treatise written about 980 A.D., a reference to an inhalation before operation of an anaesthetic called Sammohini recorded to have been used in the time of Buddha.

THE DECLINE OF HINDU SURGERY.

Hindu medicine may be said to have reached its golden age at the commencement of the Buddhist period. Hoernle in his "Studies of the Medicine of Ancient India" says "According to the Indian tradition preserved in the Buddhist Jâtakas or Folklore, there existed in India in the age of Buddha two great universities or seats of learning in which "all sciences" including medicine were taught by "professors of world wide renown."[18] These two universities were Kâsî or Benares in the east and the still more famous Takshasilâ or Taxila on the Jhelúm in the west."

Jîvaka the famous physician who was contemporaneous with Buddha is stated to have studied medicine in the Taxila university.[19]

Owing, however, to various causes this golden age of Indian surgery was destined, like other golden ages, to fade away into silver and even baser metals

[15] Susruta. *Sutrasthánam*, Ch. XVI.

[16] Haeser. *Lehrbuch der Geschichte der Medicin*, i, p. 3.

[17] Ballála Pundit. Bhojaprabandha.

[18] Hoernle *Medicine of Ancient India*, i, pp. 7 and 8.

[19] Rockhill. *Life of Buddha*, p. 65.

The ceremonial prejudice against the touching of a corpse rapidly increased, and before long it was impossible for the student to learn his anatomy from practical first hand dissection. Bodies had to be laid out in water there to be rotted away till at last the skeleton was exposed. In this way only was it lawful to get at the bones. Dissection had to be made on goats, on anything rather than the human body. Anatomy then was being lost as a first hand knowledge. The surgeon under the Hinduism of what we might call the Indian Middle Ages was becoming a person unclean. In the Manusamhita,[20] the author forbids his readers to eat cooked rice from the hands of a doctor, by which he means a surgeon.

Again with no actual general anæsthetic (for it is probable that the inhalation I have just mentioned referred rather to some sort of doping into comparative insensibility) the patient was naturally averse to an operation if it could possibly be avoided, and so we begin to find various substitutes for the knife.[21] Incisions were made by caustics and all sorts of cauteries and poultices were in use to avoid actual cutting, and as they avoided surgery so also they shrank from post-mortem examination and thus lost the last opportunity of testing diagnosis. The tide had begun to turn

Before, however, tracing its further downward steps we might now take some general review of Hindu surgery and medicine as it was at its best, understanding of course that in a paper naturally limited in length it is impracticable to go into precise chronological details as to each individual point mentioned.

KNOWLEDGE OF THE ANCIENTS.

We find then that gravitation was known to the Hindus long before the birth of Newton and that the system of the circulation of the blood was discovered by them centuries before Harvey was heard of [22] Thus Harita in the Harita Samhita, in a description of anæmia, observes that the disease is caused by clay obstructing the lumen of veins and so clogging the circulation of the blood. The atomic theory again was preached in India centuries before the birth of Christ, and their knowledge and comprehension of the sciences of mathematics and astronomy were remarkable.[23]

With amputation came artificial limbs and in the Rig Veda we have such a reference.[24] An artificial leg, we learn, was made of iron; there were, too, artificial eyes. Rhinoplastic surgery I have already touched upon, and according to Dr. Hirschberg of Berlin "The old plastic surgery in Europe had taken its new flight when these cunning devices of Indian workmen became known to us." The transplanting of skin flaps is also an entirely Indian method.

[20] *Manusamhita*, iii, 152.

[21] Mukhopadhyaya. *Surgical Instruments of the Hindus*, i, p. ix.

[22] Bhishagratna. *Susruta Samhita*, i, p. ix

[23] Wise. *Commentary on the Hindu System of Medicine*, p. ix.

[24] *Rig Veda*, XV, i. 116.

In particular the Hindu surgeons were adepts at the forming of new ears and noses from the grafting of flaps of skin. The cause of much of their practice is an oddity that we might notice in passing, the cutting off of nose or ears being a common punishment for the criminal and for the unfaithful wife.

The Harley Street of ancient Hindu surgery seems then to have enjoyed a certain amount of what one might perhaps call divorce court practice!

From the Mohāvāgga[25] we may learn that Jîvaka the physician of Buddha practised cranial surgery with success, and long before the birth of Jenner the cow-herds of India were practising a kind of inoculation or vaccination for small-pox.[26] Collecting the dry scabs of the pustules they placed a little of these upon their fore-arm, then puncturing the skin with a needle, so securing a certain immunity. According to at least one scholar, a Dr. Huillet of Pondi-cherry, actual vaccination itself was known to the Hindu surgeons. So much then on the side of surgery.

The Hindu physicians were the first to devote their attention to the study of diseases and their treatment, and in medicine their learning in many cases far antedated our own, as was only natural from the immense study given to the properties of every product of the soil. The smoking of datura for example in cases of asthma we owe entirely to India, as also the prescription of nux vomica in paralysis and dyspepsia, and very largely the use of croton.[27] Even the effects of excessive smoking come under the notice of the Indian physician.

In toxicology they had extraordinary skill and in the story of the invasion of India by Alexander, while all the Greek physicians were powerless in cases of snake bite the Indian doctors readily cured those who fell under this affliction For this reason Nearchus says " Alexander collected round himself the most prominent of the Hindu doctors and proclaimed that any soldier bitten by a serpent was instantly to repair to the royal pavilion for treatment."[28] Their number of antidotes for different classes of case was extraordinary as might be expected from a science one of whose masters, Charaka, described in his teachings no less than 600 separate purgatives.

In the field of what to-day we should call Psycho-Therapy the Hindus again held pride of place, and centuries before Freud was heard of, the Hindu doctors were anxiously probing into the secrets of dreams. With much that we were taught to regard till quite recently as absurd, their teachings show signs of a good deal of our newest learning, and in for example the theories of the Terror Dream they came at least remarkably near our 20th century doctrine of the subconscious mind.

[25] Mohāvāgga, VIII, 1, 18 and Schneifer, *Tibetan Tales*, p. 98.

[26] Ward. *History of the Hindus*, II, p. 339.

[27] Royle. *Essay on the Antiquity of Hindu Medicine*, p. 61.

[28] *Arrian's Indian History*, ii, p. 232.

Again in midwifery the Hindu was well in advance, and his early writings display a *remarkable knowledge of the* technique of this branch of medical science, including cæsarean section and what we should now call pre-natal treatment. The expectant mother, it was taught, was to be kept in a happy frame of mind, her surroundings were to be placid and pleasant and in effect the instructions that the Mother-craft Clinics of London are giving to-day and have been giving for a matter of possibly the last ten years or so were being taught as a matter of course in the ancient India of centuries upon centuries back.

Medical hygiene occupied an enormous proportion of early Hindu practice, and the science of climatology at once so old and yet to-day so young was widely practised and understood. There were three distinct sorts of country, Anupa, the moist and marshy districts where "phlegmatic" diseases and "affections of the wind" would be prevalent; Jangala, the over-dry country where ailments of the "bile and blood" would be common and Mishra, neither too moist nor too dry, too warm nor too cold. Patients suffering from various ailments would be directed to try a different country, perhaps from Unupa to Jungala or vice versa, and Mishra would be recommended generally for the period of convalescence.[29]

The codes laid down precise recommendations for the habits of patients of different types, the foods to be eaten, the clothes to be worn, even the hours for sleeping and for getting up. There was no province of human life, however intimate, for which recommendations were not to be found in the ancient Hindu medical code What we know to-day as Preventive Medicine had its origins in India many centuries back

The ritual cleanliness of the Hindu is well known, but long before the days when Brahmanism ruled every action of its votaries through the claims of caste and creed we may find the elements of the code in early Indian medicine. Take for instance so primary a case as the use of the tooth-brush (now taught in English council schools as quite a late example of 20th century western hygiene) We find quite an elaborate set of regulations on the subject.[30] A twig of Bavala, the Acacia Arabica, was sufficient for general use, but for particular cases twigs of other woods were recommended; the Indian fig tree, Ficus Religiosa, for one case, the Pomgamnia Glabra for another, the Nauclea Cadamba for a third; in all no less than twelve distinct types of tree are singled out to provide tooth-brushes for particular types of users and there is a similar thoroughness about the regulations for the tooth-powder. We here in England having delayed the matter altogether for about twenty centuries have comparatively recently arrived at the point of oral hygiene and the use of the tooth-brush!

[29] Lee *Short History of Aryan Med. Science*, p 57

[30] I-tsing *Records of the Buddhist Religion*, Ch viii, p 33

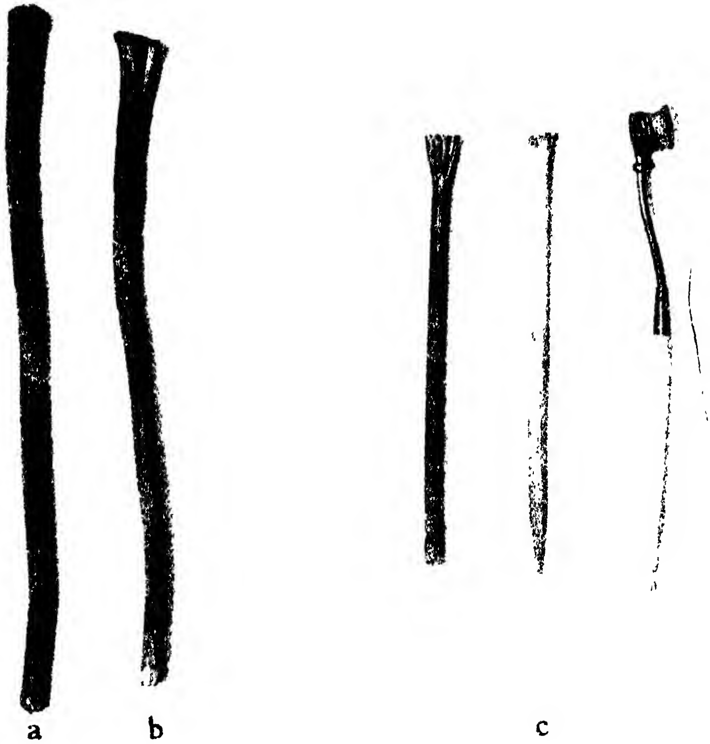

FIG. 3. (a) Twig cut for the preparation of a tooth brush
(b) Showing method of shredding
(c) Modern dental canes

(Copyright Wellcome Historical Medical Museum)

THE HINDU SURGICAL INSTRUMENTS

And if their preventive medicine, their midwifery and toxicology were thus thorough we may be certain that at least equal pains were taken with the instruments of the Hindu Fathers of Surgery. I have already casually mentioned the remarkable number of the classes of instruments, but the subject deserves far more than any such cursory glance.

We may take it that in the beginnings of all things some sort of primitive surgery was in use with naturally primitive implements, and long before the Vedas were ever set down in writing such crude instruments as bits of obsidian or glass, or skins of bamboo were employed for surgical incisions. Susruta, in codifying the knowledge of his day, had no intention of abandoning altogether the past, and in setting out on a voyage of independent discovery. We, therefore, find all these primitive surgical instruments described in his armoury and with them the more practical instruments, discovered by the experience of centuries.

So there are the Yantras and the Sastras, the blunt instruments and the sharp. Of the blunt twenty-four kinds were cruciform, two kinds pincerlike, two pick-lock like, twenty tubular, twenty-eight rod or pricker-like, twenty-five accessory and there is the same sort of variety of the sharp instruments. In general they were made of iron and their jaws as a rule were fashioned to resemble the faces of birds and beasts. So there were forceps with jaws shaped to resemble that of a tiger, the wolf forceps, the bear forceps, the butcher bird forceps, the crocodile forceps, the heron forceps and many others similar.

One remarkable point however I might mention is that precisely on the pattern of Simhanukha svastika, or lion faced forceps, described by Susruta, are the forceps now used by modern European surgeons for holding bones firmly during operations; the surgeon names his instrument "lion forceps." Although, of course, no original specimens of these instruments have survived, a very comprehensive set of exact replicas are to be seen at the Wellcome Historial Medical Museum, and I must mention here that my special thanks this afternoon are due to Dr Wellcome, the Founder and Director of this Museum, for his kindness in allowing me to use material both for the lantern slides and for the exhibits, and also to the Conservator, Mr Malcolm, and to Mr Hewitt, the Chief Librarian, for their help and assistance. On examining these instruments, they will be seen to be remarkably similar to those in a catalogue of a modern surgical instrument maker. More remarkable still perhaps is the fact that in many cases we can trace their exact genealogical descent down to our own day, for we have descriptions of many of the instruments of the ancient Greeks, Romans and Arabs, and in case after case they tally exactly with those shown here as ancient Hindu.

More, with the destruction of Pompeii many instruments were buried under volcanic ash and being centuries later disinterred are now to be seen preserved in the Naples Museum. These, too, tally in exactly every detail with many of our descriptions of the instruments of the Hindu surgeons as given in the old Sanskrit manuscripts.

Exact instructions are laid down for the building of a dispensary, even for the cases in which instruments are to be kept. Dentistry is described and students were advised to practise extraction on certain fruit seeds and on the teeth of dead animals. At some period unknown, but certainly before the 12th century A.D. false teeth were known to the Hindus. A description of the defeat of Jayacandra by Sahabuddin in 1194 mentioning the dead body of the rajah being "recognised by his false teeth." This curious passage however, I only notice as of casual interest, its date of course being long posterior to the period with which we are now dealing.

Hindu Materia Medica.

If, then, this is what we find in surgery, what may we not expect in medicine from India, that vast and fertile country which by the very nature of its

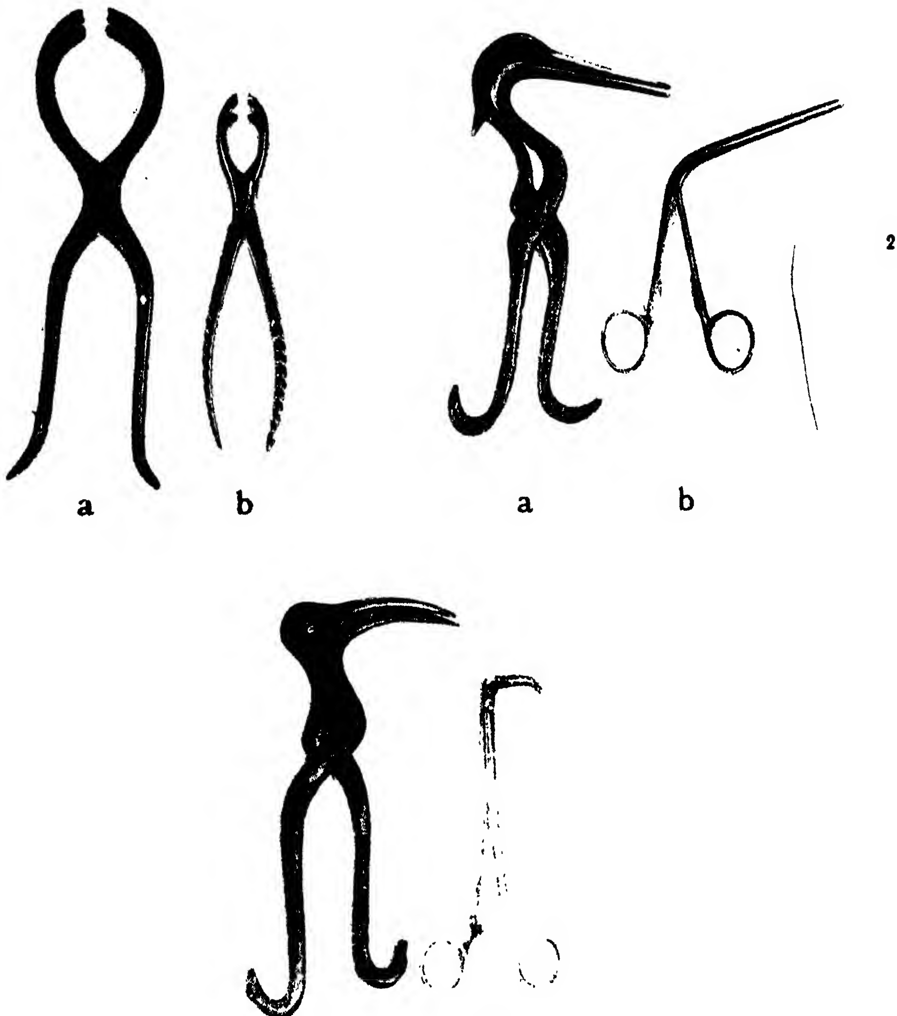

FIG. 4.—A Comparative Series of Ancient Hindu and Modern European Surgical Instruments.

1.—(*a*) Simhamukah or Lion forceps. (*b*) Lion forceps.
2.—(*a*) Heron forceps. (*b*) Aural dressing forceps.
3.—(*a*) Curlew forceps. (*b*) Ligature forceps.

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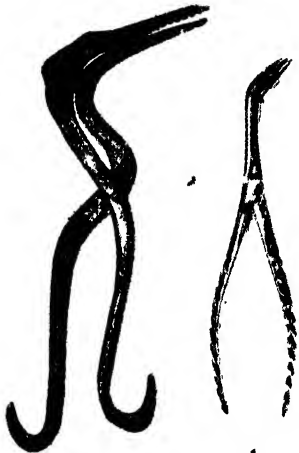
size and climate is indeed a veritable encyclopædia of the vegetable world? Nor shall we be disappointed. The materia medica of the ancient Hindus is a marvel to the modern scientific investigator; and that it was freely borrowed from by both Greeks and Romans cannot be denied



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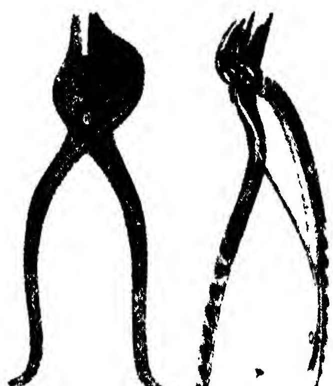

a b

-A Comparative Series of Ancient Hindu and Modern European Surgical Instruments

4.—(*a*) Crocodile forceps (*b*) Bone holding forceps.
5.—(*a*) Wolf forceps. (*b*) Skull forceps.
6.—(*a*) Tiger forceps (*b*) Gouge forceps

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Charaka makes an arrangement of "simple medicines" only, under no less than forty-five heads; Susruta, being more given to surgery, divides his medicines under thirty-seven heads. These masters passed on their teachings to their pupils who in turn supplemented them with new drugs, the fruit of their own experience. So we have Vagbhata about the second century B.C. and his stupendous Ashtangahridya, a sort of encyclopædic compendium of the medicine of Agnivesha, Charaka and Susruta; Madhava with his diagnosis

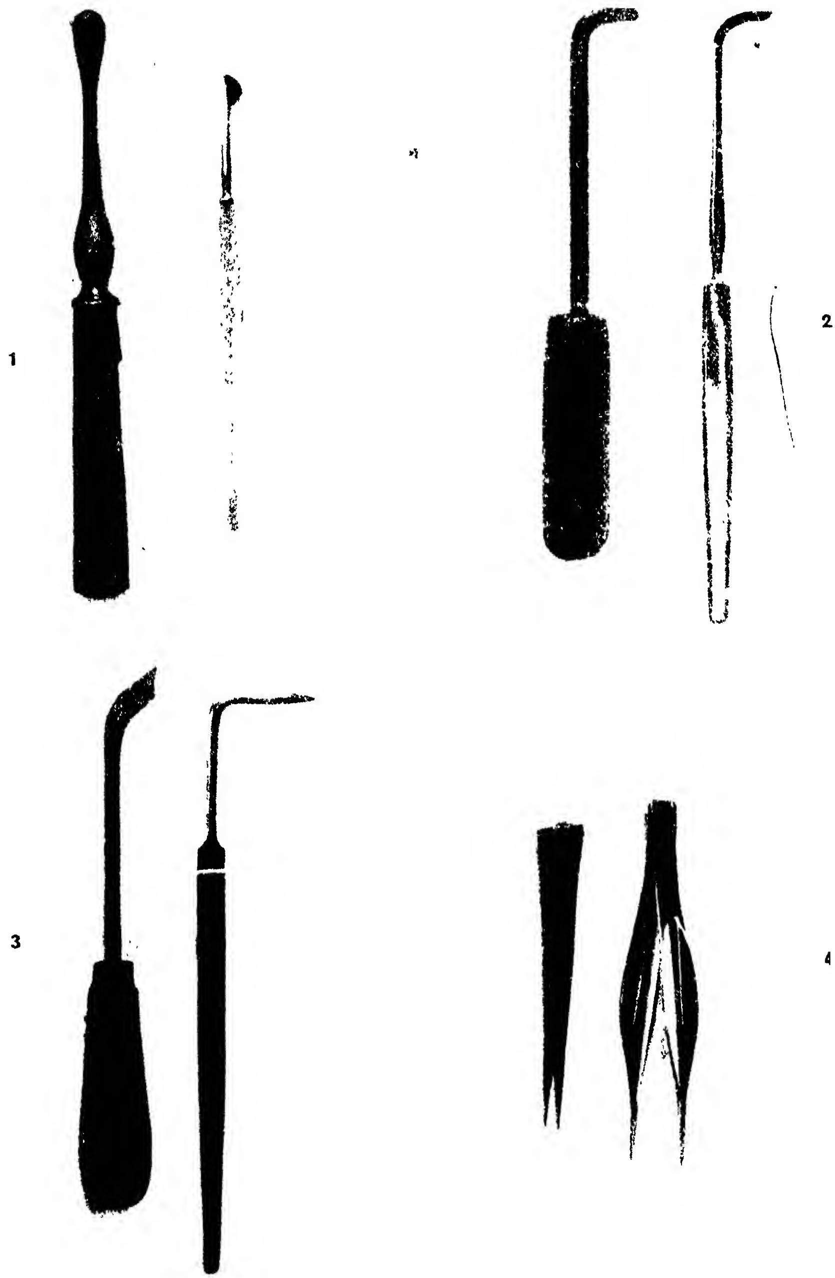

FIG. 6.—A Comparative Series of various Instruments, Ancient Hindu and Modern.

1.—Iridectomy knives. 2.—Cleft palate knives

3.—Cleft palate knives, double-edged. 4.—Splinter forceps.

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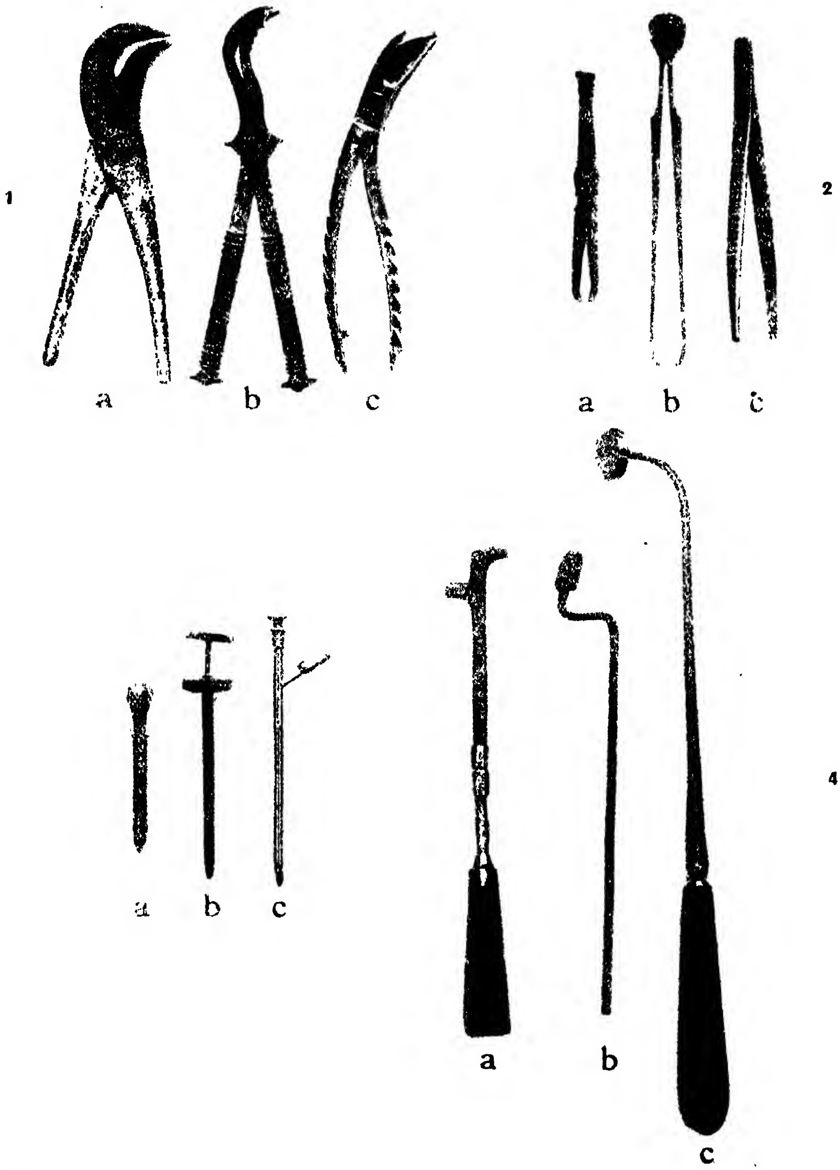

Fig. 7.—A Comparative Series of Ancient Hindu, Roman and Modern Surgical Instruments.

1.—Bone Forceps (*a*) Ancient Hindu, (*b*) Roman, A.D. 50, (*c*) Modern
2.—Long-toothed Forceps. (*a*) Ancient Hindu, (*b*) Roman, A.D. 50, (*c*) Modern
3.—Trocar and Canulae. (*a*) Ancient Hindu, (*b*) Roman, A.D. 50, (*c*) Modern
4.—Cauteries (*a*) Ancient Hindu, (*b*) Roman, A.D. 50, (*c*) Modern

(*Copyright Wellcome Historical Medical Museum*)

of disease was another giant, and there was Bhava Mishra of Benares, the "Jewel of Physicians," and plenty more. The list of Indian medical writers could continue almost indefinitely.

In the Materia Medica are described drugs belonging to the animal, vegetable and mineral kingdoms, the theory being that every substance had to be judged by its five properties, Rasa, Guna, Veerya, Vipaka and Prabhava. The first of these stood for taste—sweet, sour, salt, bitter, pungent or astringent—the sweet being more restorative than the sour, the sour than the salt, and so on. The second property, Guna, was virtue, the inherent power of the drug to cause a certain effect when taken internally or externally; under this heading Charaka gives fifty groups of ten herbs each which he says "are enough for the purpose of an ordinary physician." Agnivesha, on the other hand, gives no less than 500 classes alone of medicinal agents. Veerya stands for the power of a drug, being either heating or cooling. Vipaka was the consequence of action or change which the drug underwent in the human organism, and finally Prabhava was its adherent nature or active force.

So two drugs might both be sweet, both be heavy and both be cold and both remain similar in consequence of gastric action, and yet in effect or Prabhava the one might be costive and the other laxative. With the combined action of these five properties, in the case of many hundreds of drugs as applied to different patients with different types of disease, the physician had to make himself familiar, for as the sages had it "Medicine when administered by an ignorant person is compared to poison, being like the knife, lightning or fire; but when administered with the necessary knowledge medicine is like the Amrita, or water of immortality."

The arrangement of Materia Medica in Susruta is curious according to our idea, medicines being either locomotive or nonlocomotive.[31] Among the former fall animals whether viviparous or oviparous or "produced in moist places."

Long lists of medicines are hardly to our purpose, but in the Kalpastānum we might notice the classification of drugs and medicinal plants under their headings of Tuberous and Bulbous Roots, Bark of Roots, Bark of Trees, Trees possessing a peculiar smell, Leaves, Flowers, Fruits, Seeds, Acrid and Astringent Vegetables, Milky Plants, Gums and Resins. The list is interesting as it is in this book that we probably find our earliest notices respecting Botanical Geography, the sites and climates of different plants, the soils and seasons for collecting medicinal plants, the time that they remain good, how they are to be kept and the weights and measures of pharmacy. This Botanical Gardening coupled with the Indian pharmaceutical gardens which I shall refer to presently seems to possess a particular interest in medical history, and again it is to India that we owe it.

[31] Royle. *Antiquity of Hindu Medicine*, p. 53.

Many of these medicines can be traced directly, not only down to the Arabs but also to the Greeks and Romans. Dioscorides in his first book mentions many Indian plants particularly among aromatics for which India has always been famed. Galen and Pliny also borrowed much, but it is the work of Dioscorides that is best calculated to show to how great an extent the ancients were indebted to India and the East for their medicines There were some who used to think that the Hindus had their knowledge from the physicians who accompanied Alexander the Great on his conquests in the East, but we now know that it was to India that the Greeks, and so indirectly ourselves, owe most of their medicines. How this came about I hope soon to show. And while many drugs that had their origin in India have found their way into our own British pharmacopoeia, there were probably hundreds more Indian medicines still unacknowledged. Much as we have learned, it is possible that there still remain rewards richly to repay patient research

THE INDIAN STATE SYSTEM OF MEDICINE.

With the coming of Buddhism practical surgery underwent a still further fall. The teaching of the Buddha, the Enlightened, did not, it is true, totally prohibit the use of the knife, and it was for instance permitted to lance a boil. But on the whole it is fair to say that surgery under the new creed was so shackled and hedged about with limitations that it almost disappeared.

The student was to practise puncturing "on the veins of dead animals and on the stalks of the water-lily," while his extractions were to be made experimentally on the pulp of various fruits and on the teeth of dead animals. Flowers, bulbs and gourds were all pressed into service as models for the dissecting table. Incisions were demonstrated on bladders packed with mire and paste, lancing on hollow stalks of plants, scarification on the fresh hides of animals "from which the hair had not been removed."[32] Models of the human limbs were fashioned for lessons in bandaging, and so the regulations went on indefinitely. Little wonder that under fetters so drastic the art of the surgeon should have experienced a retrograde tendency.

But while surgery was limited, other branches of medicine under the Buddhism that now ruled the greater part of India advanced by leaps and bounds. A creed of tenets that embraced in their care the veriest insects could but pay infinite care to the ailments and ills of man himself; and so we find the whole of India soon covered with a perfect net-work of medical machinery. In the scheme of life in fact of the Buddhist priest of 200 B.C. was included the assistance of the sick, and so we have hostels for the sick, the blind, and the deformed; there were hospitals for pregnant women, hospitals for travellers. Buddha Das, we are told, established the system of State Physicians, one being appointed for every ten villages on the great roads of India.[33]

[32] *Oriental Magazine*, Calcutta, February and March, 1823.

[33] Kern. *Manual of Indian Buddhism*, p. 85 et seq.

Pharmaceutical Gardens were established to supply the herbs and drugs in Ayurvedic medicine. Arboriculture and irrigation were carried out under State supervision. In the line of Preventive Medicine laws were passed regulating burial and sanitation,[34] many modern regulations in the latter direction being antedated by centuries in the codes of the Buddhist Kings. The Royal Households set an example to their subjects in the direction of their houses and gardens. Medicinal herbs were grown in pots and certain plants were grown that had the property of warding off snakes; cats, peacocks and other creatures were kept in compounds for the same purpose, and parrots were encouraged on the grounds that their shriek was a warning of the presence of snakes. And anti-adulteration laws were drawn up on lines of strictest severity, and even carelessness on the part of a doctor was vigorously dealt with. "All physicians" the code said "who treat their patients wrongly shall pay a fine."[35] But as one commentator had it, "This refers to cases when death is not the result of the wrong treatment, for if that is the case the punishment is greater."[36]

Under Buddhism veterinary science, as we might have expected, reached an enormously high level and infinite pains were taken for the care and treatment of the animal creation. Horses, elephants, cows, fishes, game-birds, almost everything had its veterinary surgeon; the game-keeper, the superintendent of forests, the superintendent of horses, each became a high officer of the Buddhist State.

Under the government of Chandra Gupta (c. 316 B.C.) our modern system of bird and animal sanctuaries was forestalled and whole tracts were devoted to the preservation of birds, fishes, deer and other animals that did not apparently prey on life. It was no case of Forest Preservation in our English history book sense of the Norman Conquerors. Life within the Buddhist reserves was literally and absolutely sacrosanct; the Little Brother of the Christian Saint Francis had veritably come into his own under the codes inspired by Buddha. Regulation after regulation was laid down dealing with the minutest details of the proper rations to be given to different animals at different ages, in sickness and in health, and over their ailments was lavished a care which centuries later a European peasant might well have envied. All over India at the height of the Buddhist wave were set up Animal Hospitals managed for the most part by the state and staffed by the state's own veterinary doctors;[37] the term is probably more accurate than that of the more obvious veterinary surgeons which almost came to my lips. It was the Apotheosis of the Animal World. Centuries later we can still find traces of these Animals Hospitals in various parts of India and particularly amongst the Jains. This then was the state of Medicine in India at one of its most glorious epochs.

[34] Law. *Studies in Ancient Hindu Polity*, p. 95 and *Megasthenes*, Bk. ii.

[35] Vishnu. *Sacred Books of the East*, Clarendon Press, V, 175-177.

[36] *Manu*, IX, 284.

[37] *Manu*, IV, 220.

Spread of Indian Medicine.

I hope that although with several digressions I have been able to interest you in the early medical science of India and at the risk of a certain loss of strict continuity to present something like a clear story of its glories. I am now anxious, if your patience permits, to touch upon its almost marvellous spread throughout the whole then-known world. For India was no Hermit State, and the knowledge of its Sages was a fountain-head from which every country has liberally drawn. As Jacolliot remarks, "We should not forget that India, that immense and luminous centre in olden times, besides spreading its ideas throughout the East by means of emigration, from the earliest times was in constant communication with all the people of Asia and that all the philosophers and sages of antiquity went there to study the science of life."[38]

As I have already tried to indicate, up to some century ago we assumed that Greece was the beginning of all things in medical history, and if anything at all came before Greece it was some dim immemorial Egypt of which we knew little enough. Any serious medical science that India may ever have possessed must have come, we took it, from Greece, probably from those Greek physicians who accompanied Alexander and his armies to the East. This was our old point of view. It was Dr. Wise whose researches first upset the theory and who first dared to hasard the opinion that Greece and Egypt alike may both, in their scientific relations to India, have been the learners and not the teachers. As he puts it "Asia can benevolently give but it does not need to borrow: its ideas and fantasies are as exuberant as its vegetation."

To day the speculation is over and we trace how the great Pythagoras himself imbibed his mysteries from the Brahmanas of India.[39] The connection is not difficult. As long ago as the time of the thirty-seventh chapter of Genesis we find mention of the Ishmaelite or Midianite merchants trading with their caravans of spices of India and balm and myrrh of Hadrmaut. Their traffic had its regular course towards Egypt and in this trade route of the remotest antiquity we arrive at some connection between India and the West. The Phoenecians, we know, had in the Persian Gulf their "forts" for the Indian trade, while as early again as 1686 B.C. the Arabs, we are told, had opened out a trade to India. Further, from the recent discoveries which have been made during the excavations carried out on the North West of India, we have ample evidence that as long ago as 3000 B.C. there was considerable intercourse, both in trade and culture, between the peoples dwelling in this region and those of Babylonia and Egypt.[40] In the East itself the Indian learning was carried to Ceylon, to Java, and later on to China and Tibet.[41]

[38] Jacolliot. *Occult Science in India*, p. 162.

[39] Bhishagratna. *Susruta Samhita*, 1, p. viii and Berdoe, *Origin and Growth of the Healing Art*, p. 162.

[40] Ross. *Eastern Art and Literature*, 1928, p. 35.

[41] Wise. *History of Medicine*, i, p. xlvi.

Buddhism came and the Brahmin priests fled to the furthest parts of the known world. The Buddhist Dynasties sank, Brahminism was recreated and Buddhist scholars, like those Greeks who with the fall of Constantinople brought the Renaissance to western Europe, fled with their learning to China, to Tibet, and further eastwards. There are even those who say that Ancient Mexico owes much of her pre-Conquistador civilization to the arts of India, and the discoveries made by Dr. Thomas Gann in his recent expeditions to Central America disclose in a startling manner the striking similarity of the design and architecture of some of the Maya temples to those of ancient India.

Hippocrates, the "Father of Medicine," we know to have visited India.[42] For what? save the fame of the Indian physicians. According to a tale brought home to Greece at the time of Alexander the Indians had a doctor[43] whose skill was such that "he could raise the very dead."[44] Stories such as these however wildly exaggerated, speak wonders and in Greek medicine, in Arabian medicine, in what we know of Egyptian medicine, we find time after time traces of what can only have been derived from the even more ancient and famous Indian medicine. If we were to speak the truth we must call Greece not the parent of our modern medicine but its nurse. To Greece must be given the glory of nurturing and caring for the infant science, but its actual birthplace was in another country and continent.

The Fall of Indian Medicine

Very roughly I have endeavoured to show the rise and glory of the Indian system of medicine. Its decline and total fall can be traced in a few final sentences. We have seen first how the development of the Brahmin ritual system fettered the hands of the Hindu surgeon, and then how the coming of Buddhism dealt him almost his death blow. And the creeds with all their virtues did even more than this. Various branches of medicine passed into the hand of the priests, and charms and amulets began to take the place of drugs and herbs. The doctor himself became a member of a sub-caste,[45] and not a particularly honoured sub-caste at that.

Where no fresh developments in anatomy or dissection were possible all reliance was placed on the learning of the past, and the letter of the learning rather than its spirit became the rule. And into even the letter of the ancient learning as expressed in the old manuscripts corruptions began to creep. The glories of Hindu science were in rapid decline. With the coming of the Moslem conquerors the fall became more rapid. The invaders had brought their own doctors, and if their science was in many cases taken from that of the conquered of centuries back, at least it was the science of the masters, and felt no need to take into consultation the science of the mastered.

[42] *ibid*, p. liii.

[43] Yeemut ul-Twarikh.

[44] Malcolm. *History of Persia*, 1, p. 7

[45] *Glasgow Med. Journal*, 1870-71, p. 540

And so Hindu medicine again slipped down many grades. Where the Moslem Hakeems flourished under princely protection the Hindu Vaidyans held only the lowly offices of spell-makers to the poor.

With the coming of the Europeans—first the Portuguese, then the Dutch, the French, the English—the Kings of India, both Moslem and Hindu, were concerned rather with the protection of their territories, the raising of armies and the making of treaties, than with the care of science. The fire of Indian medicine had sunk almost to its last embers. The sneers of our pioneer writers at "spells and charms" were almost justified.

From 1715-1818 there seemed in the time of the Peshwas to be something like a faint revival of the ancient glories of Hindu medicine, but with the final victories of the English its hopes were extinguished, and as British rule spread all over the Peninsula European medicine was gradually introduced, and all that was left for the Hindu "Vaids" was about the position of an English herbalist. The Moslem Hakeems we might regard as Barber Surgeons, the Hindu practitioners as "Wise Women," midwives and the like. To such a pass had come the learning of Susruta and Charaka.

In bringing my subject to a conclusion I think it would be of interest to note that of late years an effort has been made to revive interest and research in this ancient science, for the Hindu system of Medicine is still to-day a living science, and millions of people in India are at the present time being treated according to this method. A system which has so survived through the centuries cannot be lightly condemned as being unscientific, and a school of thought is at present engaged in trying to bring about a sort of renaissance of the Ayur-Vedic system of medicine. In Madras, Calcutta, Benares, Bombay and other cities there have been established training centres for this purpose where the works of Susruta, Charaka and other medical classics are systematically studied, so that we may have every ground for hope that before long the true Indian medicine may once again hold its place in its own India, the birthplace of the medicine of the world.

THE CHAIRMAN, in moving a vote of thanks to the lecturer, said he was sure all present had been thrilled by the lecturer's interesting account of ancient medicine in India. A curious fact which arose was the reluctance which had always been shown by great nations in the past to tell each other anything about each other, except occasionally about religion. The Arabs, like the Indians, had been supposed to have derived their knowledge of medicine from Greece, but long before the invasion of India by the Greeks there had been a great intercourse between Arabia and Mesopotamia on the one hand and India on the other, especially the sending of Arabs or Persians by the Caliphs to India in order to gain knowledge of discoveries made there in the direction of medicine and surgery. Another curious point was why the advance of knowledge in such things as medicine came to a sudden stop. In the ninth and tenth centuries, the Arabs were probably ahead of the whole world in medicine, but they had never moved any further forward in the science. It had been the same with the Persians. The Indians,

too, had reached a certain stage of knowledge, and then had begun to fall back. He did not think that was to be accounted for only by caste having interfered with practical anatomy; he thought it was that they seemed to have reached a point, and then believed that the development of such things was not within the purview of anyone, and felt that they knew what there was to be known about medicine. The idea of improving in medicine was a comparatively modern one. With regard to kindness to animals, the lecturer did not mention the fact that the Jains had several places in India to which horses could be sent, not to be destroyed but to finish their lives quietly until they died. As to the dislike of the handling of persons, which had retarded medicine in the East, the Chinese used to have a curious system. In the Ming period the women refused to be touched by a doctor, so, in order to overcome the difficulty of diagnosis, they had constructed charming little dolls on which, when the doctor came, they pointed to that part of the body in which they themselves had pain.

SIR JAMES MACKENNA, C.I.E., having seconded the vote of thanks, which was carried unanimously, the meeting terminated.

GENERAL NOTE.

AN EXHIBITION of architectural drawings likely to be of special interest to shop and store keepers and other business men, who contemplate the erection of new business premises on modern and original lines, is being held on the premises of the Incorporated Association of Architects and Surveyors, 1, Wilbraham Place, Sloane Street, London, S.W., from Wednesday the 10th, to Saturday the 20th of July (open daily, excepting Sundays, from 10 a.m. to 5 p.m.). Admission is free on presentation of tickets, which are obtainable from the Secretary of the Association on application to the above-mentioned address. The Exhibition consists of designs submitted in a recent competition, inaugurated under the auspices of the Association, for the front of a typical commercial building, and includes designs for premises suitable for drapery emporiums, stores, boot shops, showrooms, chemists, furniture and music shops, dressmaking establishments, etc. The competition, which has aroused considerable interest among architects and surveyors, as shown by the number of drawings submitted, had as its object the encouragement of new thoughts on the old problem of the combination of sane architectural treatment with the spacious windows and distinctive facade so essential to the occupier of modern business premises.

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FRIDAY, JULY 19th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

COUNCIL.

A meeting of the Council was held on Monday, July 8th. Present:—Sir George Sutton, Bt., in the Chair; Sir Charles H. Armstrong; Mr. Alfred Carpmael; Sir D. T. Chadwick, C.S.I., C.I.E.; Captain Sir Arthur Clarke, K.B.E.; Sir Edward Gait, K.C.S.I., C.I.E.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir Henry A. Miers, F.R.S.; Mr. J. A. Milne, C.B.E.; Sir Richard Redmayne, K.C.B.; Mr. Carmichael Thomas, and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

Mr. Llewelyn B. Atkinson, M.I.E.E., was elected Chairman of the Council for the year 1929-30.

The following candidates were duly elected Fellows of the Society:—

Atkinson, Henry Wallace, Brisbane, Australia.
Bourne, Frank A., Boston, Mass., U.S.A.
Chambers, Frank P., M.A., London
Eaton, Robert Y., Toronto, Canada
Foster, Wilfred Lawrence, Mysore State, India
Hennessy, Jack F., B.Sc.A., M.I.A., A.M.I.E., Sydney, Australia.
Hornsby, Robert Wright, Santiago, Chile, South America.
Hunt, Walter, Townsville, Queensland, Australia
Khakhar, Hasmukh Maganlal, Bombay, India.
Lawley, Alfred Leonard, A.M.I.C.E., Beira, Portuguese East Africa.
Newton, Captain James Boustead, Baghdad, Iraq
Patterson, Andrew Drysdale, Edinburgh.
Power, Richard Fitz, London.
Walker, Robert Ransome, Keighley.
Watters, R. A., M.A., Sc.D., Assoc.A.I.E.E., Reno, Nevada, U.S.A.
Williams, Fleetwood Hesketh, London.

An offer from the Trustees of the Douglas Haig Memorial Homes to take over a certain group of cottages in West Wycombe and re-condition them as homes for ex-service men was accepted.

On the recommendation of the Examiner, the Thomas Gray Memorial Prize of £30, offered annually for competition among students of navigation

in the T.S. *Conway*, H.M.S. *Worcester* Training College and the Nautical College, Pangbourne, was awarded to Donald Edward Forman, Nautical College, Pangbourne. *Proxime accessit* Walker Harold Waghorn, of H.M.S. *Worcester* Training College, and Commended, Hugh H. Gordon Tracy, of the Nautical Training College, Pangbourne.

The various standing committees of the Council were re-appointed.

Sir Henry A. Miers, F.R.S., was appointed to represent the Society on a conference called by the Royal Anthropological Institute to consider the question of establishing a National Folk Museum.

A quantity of financial and formal business was transacted.

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 24TH, 1929.

PROFESSOR T. PERCY NUNN, M.A., D.Sc., Litt.D., in the Chair.

THE CHAIRMAN said the audience were met to listen to a lecture upon recent developments in educational broadcasting. That was a very important department of the work of the institution which was known everywhere with affectionate familiarity as the B.B.C. It was a wonderful institution, exercising from its mysterious den on Savoy Hill, and from its subordinate caves of mystery up and down the country, the most marvellous magic. Nobody would maintain that all its activities were beneficent or, at any rate, equally beneficent. He had heard no less a person than the Director-General himself say that when he heard the beginnings of some of the items of some of the programmes for which he was officially responsible he rushed across the room and cut out the loud speaker as speedily as possible. Yet, on the whole, there was no doubt that its magic was white magic; that it exercised an illuminating influence, and increased the happiness of that section of mankind with which it had to deal. In particular, it seemed as if broadcasting was going in the future to play a really important part in conveying to the darkest recesses of our social body some rays, at any rate, of the light which we called culture. The lecturer knew a great deal about the educational side of the B.B.C.'s activity. He knew it from two points of view: he was on the engineering staff and was therefore well acquainted with the technical side of the process, and he also had a complete understanding of the intellectual side of the business.

The following paper was then read:—

RECENT DEVELOPMENTS IN EDUCATIONAL BROADCASTING.

By H. LYNTON FLETCHER, B.A.

(of the British Broadcasting Corporation).

I wish to preface my remarks by saying that I do not desire you to suppose that my position at the B.B.C. qualifies me to make official statements regarding

either the Corporation's educational policy or regarding the considerations which govern the technique of educational broadcasting. It may be, however, that the advantage I have enjoyed of simultaneous contact with three aspects of the work—the Education Department, the technical problem, and the schools—will enable me to present a paper of general interest.

The British Broadcasting Company, under the Chairmanship of Lord Gainford, with Mr. Reith at its helm as Managing Director, came into being in the December of 1922. Its licence was granted in the first instance until the 31st December, 1924, and was subsequently, on the recommendation of the Sykes Committee, extended to the 31st December, 1926. It was stipulated at first that there should be eight transmitting stations, but before the end of 1924 eleven relay stations, a new main station at Belfast and a high power station at Daventry were added. It is important to notice that this new and powerful instrument came into being at a time when its great potentialities and far-reaching influences could best make themselves felt. Three years before the world was still rocking from the shock of the Great War. No department of State, no section of society, no industrial group but had been deeply influenced, if not metamorphosed, by the world catastrophe, and none more so than the world of Education. It was a time when everyone, who had not already given their all, gave of their best, and a time of sore trial for those faced with the task of public education. There were many who were still stunned by this triumphant demonstration of the thinness of the veneer of civilisation, but there were others happily who saw visions in the war clouds which still hung listless over our heads. A prophet of the times whose pen had already been dedicated to the service of education, wrote as follows:—

> "We stand at an hour when the civilisation that bred us is sick—some fear even to death. We cannot escape from the duty of seeking a cure for its distemper any more than from the responsibility that lies in some measure upon us all of having brought it to its present pass. But however good our will, however happy our inspiration, the problems we and those who came before us have created are problems we cannot hope ourselves to solve. They must be solved, if at all, by the generations that will take up our work when our place knows us no more. To all who would fain believe that men are not wholly the sport of circumstance or the puppets of fate, but that their own wills shape the decrees which determine slowly but inevitably the doubtful doom of human kind, it must be important to be assured that though our children cannot build a fairer world on any other foundation than our own, yet they are not bound unless in our folly we will have it so, to repeat for ever our failures, that they have in them a creative power which, if wisely encouraged and tolerantly guided, may remould our best into a life far worthier than we have seen or than it has entered into our hearts to conceive."[1]

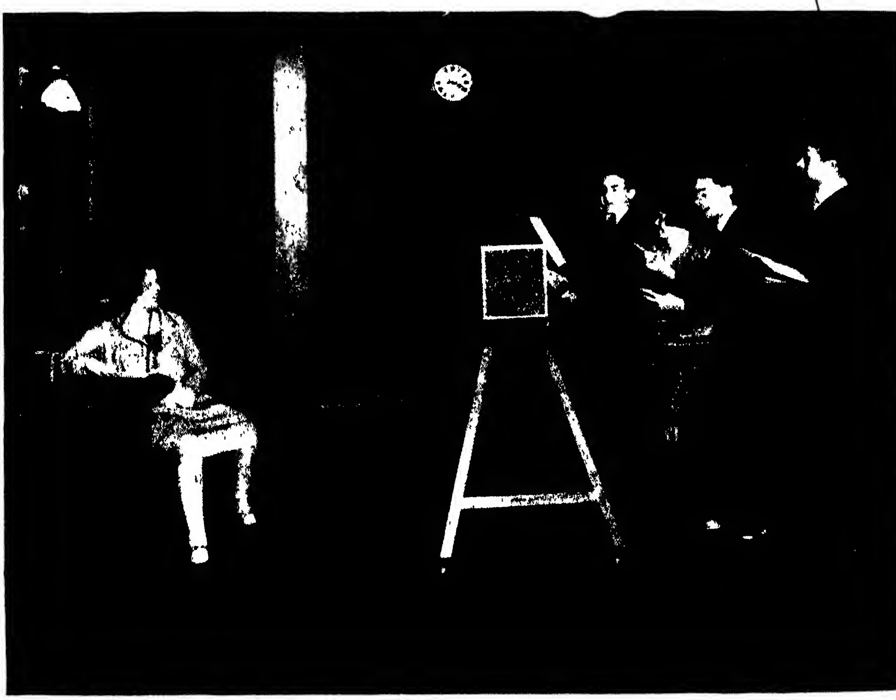
It was in some such spirit as this that educational broadcasting was conceived. In December, 1922, the back-wash of industrial turmoil, so far from having abated four years after the signing of the Armistice, had rather lashed itself

[1] Dr. Percy Nunn: *Education its data and first principles.*

into a fury, which was to reach its height four years later in the great strike of 1926.

The times were perilous, more perilous than our industrial political or religious partisans could possibly realise. And it was into this atmosphere that Broadcasting was introduced.

Of the difficulties that were primarily to be faced, the obstacles to be overcome, the rapid decisions that had to be made, the appalling responsibilities to be shouldered, I need say nothing here. Those of you who have read Sir John Reith's book "Broadcast over Britain" will already have some idea of the task which lay before them.



Play Readings.—Mr. Aubrey de Selincourt and his colleagues in the studio.
(*Reproduced by permission of the B.B.C.*)

I will content myself with saying that all the evidence I can obtain shows that from the outset the British Broadcasting Company took always the highest view of the potentialities of broadcasting in the widest cultural sense. Those who were responsible for its development were clearly determined that here should be no highly commercialised service, but that every endeavour should be made to secure that the potentialities of broadcasting should be developed in the service of the community and of the State.

It was in the month of October, 1923, that the first meeting of the National Educational Advisory Committee, including representatives of local education

authorities, directors and secretaries of education and various teachers' organisations took place. Public utility, that meeting was told, was to be the watchword of the Company. The field of education offered itself as one in which broadcasting, wisely governed, would play an enormously important part. At a second meeting of the Education Advisory Committee held in February 1924, Mr. J. C. Stobart, then His Majesty's Inspector, was present on behalf of the Board of Education in an unofficial capacity, and Sir H. Walford Davies, it is recorded, took a leading part in urging the institution of regular broadcast lessons, and it was decided forthwith that all stations of the B.B.C. should arrange for a series of six talks on music, Shakespeare, history, natural history, elementary science and travel. The Station Directors were to discuss programmes with their local advisory committees and with local directors of education, and the talks were to be transmitted on successive Fridays between 3.0 and 4.0 p.m. In May 1924, experimental series of educational transmissions were begun in Glasgow, London and elsewhere. These were the beginnings of the present service.

The Managing Director was clearly determined that nothing should be left to chance and that this work should not be handled by those who had no educational qualifications, and in the August of 1924, Mr. J. C. Stobart, who, from the earliest days of broadcasting, had himself visualised the great possibilities of broadcasting as a powerful medium for the dissemination of cultural influences, was seconded to the B.B.C. as Education Director by the then President of the Board of Education. A month later a regular daily transmission to schools began, and two evening talks daily, these latter being intended for ordinary listeners at 7.10 p.m. and at 9.40 p.m. Some of these took the form of a connected series, others were single talks intended to stimulate interest.

At a fourth meeting of the National Advisory Committee for Education, which the B.B.C. had set up, it was reported that there were then 220 schools known to be receiving the talks from the London Station. A scheme for adult education was drawn up in consultation with the Adult Education Committee at the Board of Education and a printed syllabus issued. In June, 1926, it is recorded that there were between 1,500 and 2,000 schools on the register at London. Of these approximately 70 per cent. were elementary schools, 16 per cent. were private schools, 10 per cent. were high schools and secondary schools, and four per cent. central schools. By this time an efficient service was in being. Many schools were sending in written compositions or answers to problems regularly, and terminal examinations had been instituted with excellent results.

In October, 1926, the Managing Director had occasion to address a conference of education authorities in Glasgow. In the course of his address he maintained that the period of the development of broadcasting coincided with a critical time in the history of education. "This generation," he said, "and that which

follows is faced with the urgent task of creating an educated democracy on a scale and to a degree never before attempted. The three main educational spheres in which broadcasting could operate, he pointed out, were the schools, the adolescents and the adults. He referred to some of the difficulties and said that those which arose from finance had been met in the past to some extent by the "enterprise and keenness of teachers." "The technical difficulties," he explained, "can be dealt with to some extent (at least assistance could be given) by the B.B.C." At a later stage I shall discuss how some of these technical difficulties were met.

A class listening to Sir Walford Davies's music lesson. Note the blackboard notes, the "follow up" pamphlets and the battery eliminator at the back of the set.
(Reproduced by permission of the B.B.C.)

One of the very real difficulties with which the B.B.C. was confronted about this time took the shape of an extraordinarily strong misconception on the part of teachers that wireless lessons could supplant them. Fortunately the majority realised that nothing could be a substitute for the personal element in teaching, and that so far from being in any way antagonistic to the teachers' interests, the wireless lessons would prove of great supplementary value, not only to the pupil by stimulating imagination, but also by suggesting fresh ideas to the teachers themselves. The issue of aids to study pamphlets,

in which notes and suggestions were made for preparing and following up the lesson, did much to show the teachers that without their help and co-operation the lessons were foredoomed to failure.

Another difficulty arose from a certain hostility on the part of some who "didn't want to be educated" That was always a difficulty Could Education have been called another name, could the intrinsic values of matter broadcast have been adjusted to every intellectual palate in proper proportions, the difficulty might have been obviated But this was impossible. Fortunately the responsibility was not entirely with the B B C.

At the conclusion of the address to which I have been referring I find this paragraph. "The responsibility in short falls collectively on those charged with the task of public education. The B.B.C is primarily charged with the development of broadcasting as a new medium of expression. It is only incidentally and of its own free will concerned with education. Its ability to help depends ultimately on the extent to which those interested in education will call upon it and on their willingness to create and express a public demand for the best and an appreciation of the best." That those concerned with education did call upon it and did demand the best, we shall presently see. In the meanwhile the B.B C was not going to lower its own view of its potentialities for disseminating far-reaching cultural influences Moreover, they knew what they were about. They had put their hands to the plough and there was no looking back Thus Sir John Reith in "Broadcast over Britain": "I think it will be admitted by all that to have exploited so great a scientific invention for the purpose and pursuit of entertainment alone would have been a prostitution of its powers and an insult to the character and intelligence of the people. To have left unexplored the innumerable paths along which might pass influences other than those normally associated with entertainment would have stamped as sorry fellows those to whose care the administration of the invention had been committed" These were the considerations which governed the policy under which educational broadcasting developed.

Hard upon the heels of a growing realisation that educational broadcasting would become a thing of great moment in the educational world came a proposal for the establishment of a joint committee of the British Institute of Adult Education and the B.B.C. Such a Committee was set up and met for the first time in October, 1926 under the Chairmanship of Sir Henry Hadow, Vice-Chancellor of Sheffield University.

The report of this Committee, signed on the 15th March, 1928, is obtainable under the title of "New Ventures in Broadcasting." I need not, therefore, ask you to consider it in detail now. In order that this part of my survey may not appear incomplete, however, I would like to draw your attention to certain parts of the report which are particularly relevant to my theme and which show how well justified Mr. Reith (as he was at that time) was in the expression of opinion I have quoted to you. "Broadcast education," the report tells us, "can appeal to those particular interests which mark off

sections of the public into particular groupings as well as appealing to the more general, more diffused interests." The following extract from a memorandum from the Workers Educational Association, which appears in the report, is, I think, illuminating. " Whilst the B.B.C. is probably under the obligation," it reads, " to provide for the needs recreational and educational of listeners as individual licence holders, it should not be forgotten that the experience of the voluntary educational bodies is that a large proportion of students get their inspirations for study from religious or politico economic associations, and desire education for the value it has in those connections." The memorandum goes on to deal with the question of how much weight can be given to this in broadcasting, and adds that the expression of these opinions does not carry with it a suggestion that subjects broadcast should be distorted to suit particular interests, " but rather that they should be treated as having relation to realities which various combinations of people are seeking to face and to understand "[2]

Here is what Professor Noel Baker, Cassel Professor of International Relations at the University of London says in " New Ventures " " The instrument of broadcasting is one that is peculiarly liable to prostitution to the purposes of political or national propaganda It may be suggested, therefore, that it should be part of the conscious policy of the B B.C to endeavour to establish standards of thought on international subjects that will make such prostitution of broadcasting an offence which the public opinion of no country will tolerate " I will not weary you with details of the conclusions which the report sets forth. In brief it showed that the provision of recreation and entertainment has been and still is one of the main functions of the broadcasting service, but that it is impossible to draw a hard and fast line between the two Opinions based upon the large quantity of evidence which had been called are given on the place of broadcasting in adult education and on the need for the formation of discussion groups in view of an " impressive and growing demand " that broadcasting should provide also facilities for more specialised adult education.

The fact that the value of broadcast education is of a supplementary nature is the key note of this and every other report that has been issued.

It will be understood that although the terms of reference of this Joint Committee were comprehensive, its chief work was the investigation of the relation between the B.B.C. and the voluntary bodies engaged in the work of adult education School broadcasting, as such, was not within the scope of its enquiry, although the desirability of setting up a central council for controlling this part of the work is referred to in the report.

I have sought to give you some idea of the efforts that were made by the B.B.C. at this early stage to learn the views of adult education organisations with regard to educational broadcasting, and to show you how a balance was kept between the demand for entertainment and the growing demand for specialised talks. It must not be supposed that in the meanwhile the

[2] *New Ventures in Broadcasting.*

question of broadcast lessons for schools was being neglected— far from it. As we have seen, under the direction of Mr Stobart regular transmissions to schools were organised and, early in 1927, in fact soon after the Company became a Corporation, an experiment was undertaken in the county of Kent with a view to doing in some measure for school broadcasting what the British Institute of Adult Education and B.B.C. Joint Committee's deliberations had done for the adult side. A report on this experiment which occupied the course of a year, was signed in May, 1928, two months after the issue of "New Ventures." This report, too, is available, but here again we must consider briefly the conclusions arrived at before proceeding to a closer consideration of the present position.

The Kent Report, as we have come to call the special investigation carried out in the County of Kent during the year 1927, was the result of a "growing feeling that some external investigation of the B.B.C.'s potentialities in respect of schools was extremely desirable."[3] Kent was convenient geographically, and the Kent Education Committee offered every facility and encouragement. The United Kingdom Carnegie Trust provided a sum of £300 to help to defray the expenses of the enquiry, and £1,000 was obtained through private generosity. The scope of the enquiry covered elementary schools, and during the course of the experiment three conferences were held and were attended by representatives of teachers, representatives of the Kent Education Committee, of the B.B.C., and by H.M. Inspectors for the area. It was part of the B.B.C.'s intention in inaugurating this experiment in Kent to decide how some of the difficulties which had already been recognised and classified, might be overcome.

The technical difficulties at first were prominent. It was recognised particularly that the experiment could not be successful if any strain was imposed upon the children. This meant that good reception—that is to say, reception which enabled the children to hear every word of the lesson without strain or undue effort, was an essential. A service of advisory engineers (about whom I shall say more at a later stage) was provided, and every effort was made to secure that the conclusions to be drawn from the experiment should in no way be prejudiced by imperfect reception. I think the technical difficulties deserve a section to themselves, and I shall not dwell upon them here.

The report draws attention to the fact that Mr. Stobart's knowledge of elementary schools had led him to feel strongly "that the elementary school curriculum could be enriched by supplementary lessons."[4] Contact with fresh personalities, records by eye witnesses of events described in the text-books which the children used, a fresh voice, and a change from descriptive methods to which they had been accustomed, could not but stimulate the minds and broaden the outlook of the pupils. There would be, of course, an effect upon the teachers too. Such talks could not but bring the teacher

[3] See *Educational Broadcasting—a report of an experiment in the County of Kent.*

[4] See Kent Report.

new ideas and suggest new methods of introducing old ideas. The Report amply bore out the feeling that in the supplementary value of the broadcast lessons lay their strongest claim, and the choice of subjects for broadcast purposes was governed by these considerations, the criterion of selection being the extent to which the various subjects could be so treated as to stimulate a desire for further knowledge and an enthusiasm for a closer consideration of subjects to which the children were already receiving an introduction. Such subjects, as the Kent Report records, were geography, where a traveller, such as Mr. Clifford Collinson, could relate his actual experiences in foreign countries; nature study, where the specialist's knowledge is of first importance; history, because this is a field in which the specialist can supply a first hand and vivid background, and so on.

Sir Walford Davies broadcasting
(Reproduced by permission [illegible] B.B.

It was found that "there was a real and persistent demand from teachers for courses of wireless lessons in subjects associated with the ordinary subjects of the curricula."[5] "In the opinion of the teachers," says the Report, "the broadcast lessons (*a*) imparted a knowledge of facts, (*b*) stimulated interest in ways which could be definitely observed, (*c*) created impressions as durable

[5] Kent Report

as those produced by their ordinary lessons, (*d*) did not encourage inattention, (*e*) were particularly stimulating to clever children, (*f*) supplied views and information which the teachers themselves could not have supplied, (*g*) gave them fresh ideas for lessons, (*h*) interested some parents in the work that their children did in school." The Kent Report also tells us that the lecturer should be an expert, possessing some of the qualities of a teacher, and having some knowledge of the conditions prevailing in the schools of the type to which he is lecturing—that there is much to be done to ensure better co-operation between lecturer, teacher and pupil, that the teacher who takes charge of the broadcast lesson should not be out of sympathy with educational broadcasting, and that it is essential that efficient arrangements should be made for the upkeep of receiving apparatus. I am passing somewhat briefly over this important report because it is now over a year old. I do not think that on this account its conclusions are in any sense out of date, but we have learnt much in the meanwhile, and it is with this that I would rather occupy your attention.

In January, 1927, the B.B.C. had undergone a change in constitution and status, and from being a Limited Company it was reconstituted, following the recommendations of the Crawford Commission, as a Corporation by Royal Charter. The Board of Directors gave place to a Board of Governors with the Earl of Clarendon at its head, and the Managing Director became Director-General. Contrary to the fears expressed by many, neither the policy nor the programmes appeared to suffer materially. Educational Broadcasting became increasingly popular.

By this time the number of schools on the register had enormously increased, and contact had been made between the B.B.C. and education authorities and schools all over the country. Conferences and demonstrations had been given in London, Oxford, Liverpool, Kent, Bournemouth, Sheffield, in Scotland and in Wales, and by now the time was approaching when the B.B.C. felt that it was becoming desirable to set up councils to take charge of this side of the service. The report of Sir Henry Hadow's Joint Committee of the British Institute of Adult Education and the B.B.C. had suggested the establishment not only of a central council for broadcast adult education, but also one to take charge of Broadcasting to Schools, and the Kent Report ratified this suggestion.

Accordingly, in June, 1928, the National Advisory Committee to which the B.B.C. had looked for assistance in the development of school broadcasting decided to resign in a body so as to facilitate the setting up of the suggested council. An Interim Committee was appointed consisting of representatives of educational organisations, including the Board of Education, and of certain nominated members, with the object of making recommendations as to the constitution of the proposed council.

The Council has now been set up and is known as the National Central Council for School Broadcasting. It comprises twenty representatives of well-known and themselves representative educational bodies, and fifteen members nominated on account of their special qualifications for work on the Council. It was fortunate in persuading the Rt. Hon. H. A. L. Fisher, sometime President of the Board of Education, to act as its chairman.

Subject to the overriding power of the B.B.C. in regard to the terms of its Charter, the censorship of matter broadcast, questions of copyright, matters of broadcast technique and management, and finance, the Council has wide powers.

Meanwhile a Council for broadcast adult education had also been set up, and its powers were not dissimilar to those of the Schools Council.

This brings me in my survey more or less up to date, and I am now in a position to say something about the claims which can be made and the limitations which are recognised in respect of educational broadcasting to-day. So far I have been concerned very largely with history, and for the moment I am not going to leave this comparatively safe ground for the uncharted seas of conjecture. I am not at the moment concerned with my own views, and therefore in outlining the claims and limitations of educational broadcasting I cannot de better than quote them as they were expressed by Mr. Stobart to the Imperial Conference in June, 1927.

[6](1). "Wireless can bring the pupils of the remotest schools within reach of the influence of experts and scholars of the highest standing.

(2). It can virtually add to the staff of a school by providing a fresh outlook and fresh voices. The effect of this upon the composition in the widening of vocabulary is very clearly marked.

(3). It can overcome the isolation of a school by enabling it to participate in such events as Armistice Day Celebrations in London, Evensong from Westminster Abbey, Empire Day, etc.

(4). It can be used in the evening as a medium of higher education, and a means of encouraging ex-pupils to pursue their studies.

(5). The exercise of concentrated listening to a continuous train of thought clearly spoken in good English is valuable mental discipline.

(6). The almost unlimited resources of broadcasting enable the B.B.C. to provide some things which no school, however wealthy and well staffed, could possibly provide, e.g., orchestral concerts, acting of Shakespeare by trained actors, travel talks by the actual explorers, etc.

On the other hand :-

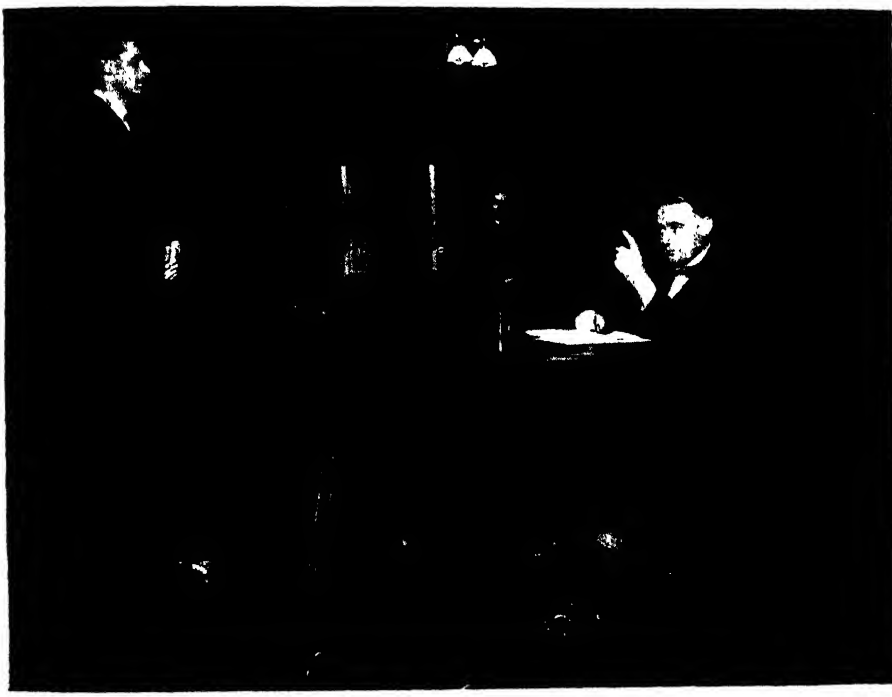
(1). Wireless cannot replace the living teacher. Indeed, it only attains its full effect when the teacher is able to co-operate by listening himself, correcting pupils' notes, clearing up points of difficulty and revising the wireless lesson to ensure that the points have gone home. For this purpose the B.B.C. issues printed pamphlets containing blackboard notes, maps, diagrams, etc.

(2). The wireless lesson must always partake of the nature of a lecture. The B.B.C. does not claim that the lecture method can play anything but a sub-

[6] *Educational Broadcasting.* A survey submitted by the British Broadcasting Corporation at the Imperial Conference on Education, June, 1927.

ordinate part in primary or juvenile education. For this reason the wireless lesson is placed near the end of the day's work, when it will be found to offer a stimulus and a change.

(3). There is some loss of personality through invisibility, but a great deal of personality can be conveyed by the living voice properly transmitted. Imperfect transmission is a fatal obstacle, and the B.B.C. has no desire to have classes listening on imperfect apparatus. It is the universal experience that where speech is transmitted, with its full quality, the interest of the class is well maintained.



Languages.—"Répétez après moi". M. Stéphan at the microphone. The announcer on the left of the picture is repeating the phases sotto voce to signify the time required for the children to repeat

(*Reproduced by permission of the B.B.C.*)

(4). From the nature of things it is impossible for the B.B.C. to meet the needs of the time-tables and curricula of all schools. The areas they cover are far too great. They have to aim at a curriculum which will illuminate or consolidate the ordinary work of the average school. In languages, for example, the wireless lesson can hardly teach the whole thing from A to Z in the time available. It can give the voice and accent of a Frenchman as an aid to ordinary classroom tuition.

(5). It is only within limits that wireless can provide for expression on the part of the pupil. The B.B.C. invites teachers to send up samples of work, which are marked and returned. Praise at the microphone is found a valuable stimulus in many schools, but where teachers object to such honourable mention, they are in no way bound to submit specimens or to enter for examinations."

There have been and there still are difficulties to be faced. There are still, I am sorry to say, many people who really think that educational broadcasting can succeed without the teacher, that a loudspeaker can be introduced into the classroom and that the children can profit by lessons so heard. We feel sure that this cannot come to pass. The whole essence of the lessons lies in their supplementary character. Without follow-up work, without careful preparation and careful supervision, the talks would have little value. There have been difficulties, too, on account of time-tables and there have been cases, as the Kent Report relates, in which H.M. Inspectors have had reason to complain that too many broadcast lessons have been taken. It has been important to persuade teachers to realise that the intellectual fare provided has been intended to be taken, to use Mr. Stobart's metaphor, on an *à la carte* and not on a *table d'hôte* basis.

This brings me to the important consideration of technical problems into which I do not propose to go too deeply, though I shall try to show you how the B.B.C., when it was recognised that this was an important part of the whole, sought to give all the assistance that it could. Even in the earliest days of development it was realised that many technical difficulties would have to be overcome before the claims of educational broadcasting could finally be established. Good reception, always to be desired, would be, as I have said, a *sine qua non* when the attention of a class of children was to be focussed on the loud speaker for twenty minutes or for half-an-hour at a time. The B.B.C. realised this and resolved that although it could not lift both ends of the stick, the transmitting and the listening end, yet it would give practical proof of its anxiety to make its service of educational transmissions of maximum value, by investigating the technical difficulties at the listening end, and by giving such advice and assistance as it could.

In the autumn of 1926 an "education engineer" was appointed. His duties were threefold:—(1) to raise the standard of reception in schools by giving advice and by making suggestions about how existing sets could be improved, or about how a set could be constructed on the right lines, (2) to answer teachers' inquiries about the claims of educational broadcasting, and (3) to collect and pass on to the sections of the Education Department concerned such information as could be obtained about the conditions which prevailed in schools and about the suggestions, criticisms, and difficulties which the teachers voiced.

That was two and a half years ago, and since that time the staff of education engineers, all having, in greater or lesser degree, the qualifications for duties to which I have referred, has been increased to fourteen, and it has become necessary to build up a small organisation to render their work of maximum value.

With the growth of this section and an amazing increase in the requests for assistance, the scope of this side of the work increased. It is not perhaps

for me to say that this fresh indication of the B.B.C.'s determination to help to make broadcasting a significant factor in the service of education, was tremendously appreciated by the schools. Nevertheless it is a fact, and when it became known that the B.B.C was willing to place the services of fourteen men, selected as far as possible for their combined knowledge of receiving apparatus, and the conditions which prevail in schools, at the disposal of educational bodies without cost to the schools, the demand for personal visits became enormous. The number of schools visited by request in 1928 alone was 2,276, at an average rate per week of 43.7, and in October of that year no less than 313 schools were visited (an average of 78 per week). What could be done by personal visits was supplemented by the issue of specifications for one, two, three and four-valve sets suitable for use in schools and by adult education organisations. These specifications, which have recently been revised and brought up to date, were and are made available free of charge to all who are concerned with the work. Assistance is given also through the post, and the work of dealing with the questions raised in this way occupies the time of a small staff at Head Office who are also concerned with the arrangement of the demonstrations to which I have referred, and of which there have been 117 up to the end of last year.

In the early days, of course, the technical problem assumed greater proportions than it does to-day. Many people had spent large sums on apparatus which was unreliable, and it was by no means uncommon to find children listening to broadcast lessons under incredibly bad conditions. In some cases a sort of *post hoc ergo propter hoc* confusion resulted in schools giving up the lessons as valueless, whilst in others, although the failure was rightly attributed to poor reception, it was not realised that a very much higher standard was obtainable. To demonstrate this standard became an important part of the duty of "Education Engineers."

Though this work is strictly confined to the education side of the service, it occupies the full time of the fourteen men to whom I have referred. The assistance is not confined to schools, of course, but is given also to adult organisations, though not to individual listeners.

Earlier in my paper I made reference to the earliest subjects which were chosen as being peculiarly adaptable as media through which a supplementary stimulus could be given to the pupils' imagination. I need not tell you about the courses which have been developed from these early ideas. The B.B.C. issues a programme and syllabus for both broadcasts to schools, and talks and lectures for adults– which can be obtained from the B.B.C.

I shall not have time to talk about Educational broadcasting in other countries. "Most continental stations," says 'New Ventures,' "arrange talks of a practical or of an educational kind in the day time." The talks usually last for about half-an-hour, and except in America, they are not of the same type as the short talks arranged by the B.B.C. "New Ventures"

tells us that by far the most important attempts outside Great Britain to utilise wireless in the service of education have been made in Berlin by the organisation known as the Deutsche Welle.

I have endeavoured—without, I hope, making my paper too long—to give you a brief survey of recent developments in educational broadcasting.

I hope you will forgive me for having dwelt so much on the expressed views of other people—and for having quoted so freely ; but the essence of a survey, as I understand it—is to put forward in palatable form, the bare facts of the matter.

Now -what of the future ?

To conjecture about the future of educational broadcasting is something which I feel neither able nor qualified to do. To attempt to read the signs of the times—especially as they are writ as large just now as at any time in history —and to suggest how broadcasting seems to lend itself to the service of education in a comparatively unexplored field is something I shall try to do

In attending educational conferences one is struck by the amazing similarity between the high ideals which characterise the vast majority of presidential and other addresses one hears—and at the amazing support which—at the time —is always given to one Ideal in particular.

I almost wish I were a teacher so that I could, as Sir John Adams does—disarm criticism by reminding you that when Scott seeks an excuse for the errors of Reuben Butler he says " for the man was mortal and had been a schoolmaster." Fortunately, however, one can often pass on things to others which one may not oneself be credited with understanding.

A story is told of a parrot whose owner sought to teach it to talk. " Lieba Laura " he said to the bird each day as he sat before its cage, trying, contrary to all the best theories of heuristic methods to make it acquire something by vain repetition. The parrot was adamant. Its apperception masses were distinctly thin. Its owner, who had neither the patience nor the persistence of a Nunn, nor a Montessori, gave it a week. At the end of that time he wrung its neck and threw it, possibly, as a horrible example, amongst its cousins in the hen pen. Early next morning remorse shook him, and hastily dressing, he went out determined to atone in some degree for his hastiness by giving the bird a proper funeral. But the parrot was not dead, though six of his prize pullets were, and clinging triumphantly to the neck of the seventh was his parrot all cock-a-hoop, shrieking cacophonously into the unfortunate chicken's ear " say Lieba Laura, then, say Lieba Laura."

That is my apologia.

The ideal which is the keynote of so many speeches and addresses on education takes the shape of the aphorism " Individuality is the ideal of life."

In the past five years I have not heard a good speech nor read a sound book about education which did not either assume the truth of this statement, or seek to describe and elaborate methods of teaching to the end that individuality

might have scope to develop—as develop it does—in an atmosphere where there is an abundance of common interests and varied experiences.

It is an aphorism the truth of which is being impressed upon this generation as vigorously as is the poignancy of the unemployment problem.

Those who awake early in life to a fear that they are in danger of being intellectually equipped with bows and arrows to fight in a world where their elders and betters use powder and shot, dimly recognise that individuality is their heritage, and they seek it—or the atmosphere in which it develops—within the confines of their environment.

One does not have to be a student of the art of education to believe that Education must aim at the cultivation of individuality. It is a thought which pervades.

All our literature is full of it. Pestallozzi gave it to the World—Froebel philosophized about it and developed it, Herbert wove a Psychology round it; Montessori is full of it. William James never allows one to forget it. Sanderson of Oundle applied the principles which underlie it as, in a lesser degree, Thring of Uppingham did before him. Every psychologist, philosopher and schoolmaster writes and speaks of it. Only those whom Professor Laurie brands as "Teachers by the Grace of God" fail to see it.

There are some things in life so overwhelmingly convincingly *right* that one does not question them. This is one of them—this idea that the real aim of education is the cultivation of character and the preparation of man's environment, to the end that his individuality may have complete freedom to develop.

It seems unthinkable that any other lesser considerations should govern our systems of education. But they do. They have to.

Those charged with the task of administering public education are faced with a grim task--about half a million children pass out of our elementary schools annually. They have to be intellectually equipped to live and move and have their being in a certain environment, the nature of which can often be anticipated. It's all very well to talk of giving their individuality opportunities of developing—it's of precious little use to them without the three R's. They have to earn their bread and butter in a world where individuality isn't at a premium.

The problem is one which has been recognised and faced. Great efforts have been made so to adjust the values of subjects taught at various stages of development that neither the knowledge which the child acquires nor the experiences from which his power to form judgments is obtained should be ineffective in making him a useful member of society.

What is known as the problem of post-primary education offers the greatest difficulty. The Haldane Report (The Next Step in National Education) confirmed the growing feeling that from the age of eleven onwards all normal children needed "schools of a new type adapted to their varying needs and capacities." The report tells us that "This problem of liberalising the

curriculum and of bringing it into closer relation with the realities of the world and the interests of the pupil, will become ever more urgent as secondary education extends and includes a larger proportion of the adolescent population within its range."

Fortunately broadcasting is not faced with the same task. It is not concerned with the task of Public Education and it is therefore all the more free to fulfill this long felt want.

The Report speaks of bringing the curriculum into closer relation with the realities of the world.

Surely this is just what the broadcast lessons are designed to do?

The supplementary courses arranged in connection with the teaching of History and Geography are typical examples. It would be hard to imagine anything better calculated to make a realistic appeal to the imagination than one of Mr. Clifford Collinson's travel talks coming on top of a sober study of the geography of the places he describes.

Dr. Nunn in "Education: its data and first principles" reminds us that "a normal child's appetite is as varied as it is vigorous, and that it can rarely resist the temptation to emulate another's exploits, so that it is not often difficult to make him take his intellectual meals provided that the fare is properly chosen and attractively set out."

Broadcasting provides a medium through which the child can come in real contact at first hand with just such exploits. As for choosing and setting out the meal attractively, I can only tell you that to watch a class of children listening to Miss Rhoda Power describing a country fair in the middle ages is a sight that does one good.

"Data and first principles" also tells us that individuality only develops in a social atmosphere where it can find common interests and common activities.

Broadcasting can help to create that atmosphere.

The Armistice Day Ceremony; the Broadcast from the Menin Gate; events of great national significance—these are of the essence of common interests—it is through such things that we learn to unite in a common bond—we and our children. This way lie the means of inculcating ideals. "Art and literature," writes William Chandler Bagley in "The Educative Process," "poetry, the drama and fiction, music and religion, are the great media for the transmission of ideals and as such fulfil an educative function far more fundamental than our didactic pedagogy has ever realised."

I am not making a play on the word transmission but none of these things—neither poetry, drama, music, religion nor fiction, are omitted from the programmes.

It is unfortunate that since the connotation of certain terms brings a sort of standardised denotation in its wake, we cannot change them altogether. Education for instance. For many of us it has come to denote an uncongenial atmosphere in which textbooks, time-tables and examinations predominate

just as the term religion still, alas, conjures up for many an atmosphere redolent only of churches, prayer books and controversy.

Those who have studied the principles of Montessori as applied to children, or the Dalton plan as applied at a later stage in life, have found that this tendency to put education into a separate, definite, uncongenial category has been a great obstacle, just as our real religious reformers rank as their greatest enemies those whose religion is brought out on the Sabbath to be burnished up for the edification of their neighbours.

Broadcasting does not lay the emphasis on the formal values of its subject matter There is an appeal to the imagination. "We should take the child seriously," says Dr. Nunn, "as he takes himself, as poet, or dramatist, engineer, surveyor, chemist, astronomer or sailor, and should help him to explore as fully as he craves, those concrete modes of self-assertion. . His studies should be so shaped as to help him to be in imagination and in anticipation a sharer in those phases of human effort which have most significance for civilisation as a whole. His history and geography should look largely towards politics in the wider sense, and economics His science should make him a fellow worker with men like Pasteur; his mathematics should teach him the value of abstract thought in relation to the practical affairs of life, for teaching given in the spirit thus indicated makes as direct an appeal to the play motive in the adolescent as the invitation to make believe does to the child."[7]

I suggest that along such lines as these broadcasting can do a tremendous amount to bring children, through the ordinary subjects of their curriculum, and without interfering with their vacational studies, into touch with the realities of life

The rector of a parish in Llandudno, in the course of an address delivered at Easter to members of the National Union of Teachers Conference, remarked that all the history he could remember was William - 1066. He would not have minded so much, he told us, if only they had told him *why* he should remember William 1066 But that was in the days when, as Sir John Adams puts it in order to teach John Latin one had to know Latin, but not necessarily John.

You see I have unblushingly torn from their contexts some of the utterances of our educational psychologists with whose writings you are no doubt very much more familiar than am I. But you will agree that this is a field in which broadcasting has an important part to play? And even if some of the aphorisms I have quoted were not meant to stand on their own feet, do they not take on a new significance with the potentialities of broadcasting as a background?

The method of illustrating my point is, I hope, at all events, preferable to voicing metaphors, which, as Adams puts it, have a way of getting the bit between their teeth and leading one far from the point. Broadcasting can

[7] Dr Percy Nunn, *Education: its data and first principles.*

do much to make this ideal of education—the cultivation of character—a more tangible thing.

William James, writing on the things that make a life significant, reminds us that " life is soaked and shot through with values and meanings which we fail to realise because of our external and insensible point of view."[8]

The first-hand experiences which broadcasting can bring us must surely render our attitude towards life less external, less insensible, less "aloof ? " You can't hear Sir Walford Davies explain the language of music and afterwards hear the Unfinished Symphony without getting a glimpse of the meaning and the values it holds for other people ?

There is a grave absence, we are told, in the life of the nation of three essential things—fixed principles, comradeship, and vigorous aspiration.

We are wont to say that the cataclysm of 1914–1918 was a war to end wars ; that never again would man submit to such a useless, hopeless, horrible annihilation of all that is best and greatest. How many of us really believe that we are as far away from the possibility of a repetition of anything of that kind as we would like to believe? Most of us have an amazing tendency to refuse to see things we do not like seeing, and to refuse to hear things we do not like hearing. I do not think, however, that anyone to-day would deny that there is still much to be done to supplement the curriculum and to brighten the environment which are the heritage, thanks to our education Acts, of all children to-day. Broadcasting can play a great part in teaching children, and grown-ups, too, not only what to think, but how to think, in showing them, if possible, that such things as prejudice and bias, which lie at the root of all our trades and industrial disputes, are, after all, but forms of psychological phenomena which, like complexes, have only to be explained to be understood. Broadcasting can help us to know how to set about seeking the truth that sets us free—it can teach us what William James tells us is the first thing to learn in human intercourse : " non-interference with each other's peculiar ways of being happy," and it can teach us—again I must turn to Dr. Nunn— " that freedom for each to conduct life's adventure in his own way and to make the best he can of it is the one universal ideal sanctioned by nature and approved by reason ; . . . . ."[9] That broadcasting can bring us nearer to that ideal I am certain.

It rests with the teachers.

I wish to make my acknowledgements to the B.B.C. for permission to read this paper, to Captain C. G. Graves for his valuable comments, to Mr. Bishop (also of the B.B.C.) for reviewing my references to the work of Education Engineers, and to Mr. E. M. Rich of the Education Department of the L.C.C. for his advice.

[8] *Talks to teachers on psychology and life's ideals.*

[9] Dr. Percy Nunn, *Education : its data and first principles.*

I am also particularly glad to have this opportunity of placing on record my sincere gratitude to Mr. Stobart, B.B.C. Education Director, without whose personal friendliness, advice and guidance in the past two-and-a-half years it would have been impossible for me to have attempted a survey of this kind.

DISCUSSION.

THE CHAIRMAN said the audience would agree that they had heard an extremely interesting survey of the educational activities of the B.B.C., and a very able *apologia* for them. The lecturer's text had been very interesting, but, personally, he ventured to think that he had been even more interesting when he had got away from his text. The lecturer had dealt so comprehensively with the problems of broadcasting that it would be impossible for anyone to follow him through the paper even with the briefest comments. His (the Chairman's) best plan would be to confine himself to pointing out how broadly the lecturer had treated the question, and in what a modest spirit, as an official of the B.B.C., he had dealt with the problems which that Corporation had to face. In particular, the audience must have been struck with the way in which the lecturer insisted that success in broadcasting was not a matter for the B.B.C. alone. It was essentially a question for co-operation between the Corporation's officers and the schools. There was an educational technique of a definitely new kind to be worked out, and the Corporation was fortunate, and the education of this country was fortunate, in that attempts to work out that technique were being fostered by young men so able and enthusiastic as the lecturer.

CAPTAIN P. P. ECKERSLEY said he did not know if the audience realised the relative positions between the lecturer and himself. Personally he considered the lecturer was neither flesh nor fowl nor good red herring at the B.B.C. The lecturer was partly on Mr. Stobart's staff looking after education, and he was partly on his (Captain Eckerley's) staff looking after the technical side. Whenever Mr. Fletcher did anything really good, and was worthy of being on the engineering side, he immediately said to him, " Wonderful ! " When, however, the lecturer did something of which he (Captain Eckersley) did not approve, he said, " Oh, those educational people ! " On the present occasion, however, the lecturer was definitely on the technical staff !

Those present had listened with great instruction to the lecture. Personally he had learned a great deal about the educational side of the work. He knew perfectly well why Mr. Fletcher had left out the technical side. It was because he expected himself to deal with that side, feeling for once that he was boss. However, he was not going to say anything about the technical side at all. He was going to challenge Mr. Fletcher upon his own ground, because he felt that nobody who opened a discussion should, by any manner of means, agree with the lecturer in any way ! There did seem to be a different point of view which one might take up about the whole of the broadcasting service. He would challenge Mr. Fletcher by asking him : Was it really necessary to insist upon the educational side of broadcasting, when the broadcasting service, run properly, was essentially educative in itself ? What he meant was that the very fact of playing a symphony, of allowing a certain person to talk, of having a cultural ideal behind broadcasting, gave it an intrinsic value, and made broadcasting educative by little homeopathic

doses so that people hardly knew they were being educated. And one wondered if that was not the best way of educating people. One wondered, in fact, if the label "education" did not cause more "clicks" throughout the country than any other word in the language. Very stupid people said, "When I come home in the evening I want to be amused; I do not want any of your education, I am tired, and I want to listen to a good old military band." Such people were probably perfectly sincere. Directly it was stated that there would be an educational talk, they "clicked." It was possibly in the wrong spirit to say to such a man what was said by the lady in *Punch* who was taking her child out for the day. She was dragging her little girl, who was crying bitterly, along with her, saying: "You have come out to enjoy yourself, and enjoy yourself you will, you little beggar." Personally he often wondered if the label "The educational hour" did not tend, to an extent, to destroy the good which might be done by gentle insinuation. It was such labels that made people say, "I resist this thing," whereas they could be brought to an unconscious enjoyment of it. It should be pointed out to them that, really and essentially, amusement was education.

The first time a man heard a difficult piece of music he said, "I did not enjoy that at all," but if it was a good piece of music, and he persisted in listening to it, he would soon get to enjoy it. For instance, when he himself had had his first whisky and soda he had thought it was filthy, but he had persisted and persisted so much that he could hardly now do without it. It seemed to be very much the same with the B.B.C.'s educational work. At first it might be thought nauseous, but in the end become to be looked upon as invigorating stuff sent into the minds and ears of the listeners, who would eventually find themselves educated without knowing that they had been. Therefore he asked Mr. Fletcher if it was really necessary to go round to the schools, to insist upon formal education, to label things too much, to make a formal song and dance about it, when it might be intrinsic in the whole affair?

He was second to none in believing that broadcasting had an enormous future before it. Broadcasting, properly handled, could give a leadership as nothing else in the world could. It had possibilities and potentialities greater even than those held at present by the commercial and competitive press. The press of this country were under the terrible obligation of getting advertisements, of making profit and of going down to a certain level because they had to be competitive one against the other. Broadcasting had none of those disabilities. He would utter a serious note of warning in regard to broadcasting, and that was that its responsibilities were so enormous that it must not go to the other extreme of getting a superiority complex. It must realise that it was in the end a thing which should have a leadership, which should have a conscious ideal that should not label itself and that should not be too organised or too formal, but which still had to remain human if it was to get the confidence of the people who listened.

That was his criticism of formal education—that it was taken with a measure of suspicion by people. If he might suggest it to the lecturer, possibly more good would be done without too many labels, without too many principles, but with a good deal of humanity. That was his sole challenge to Mr. Fletcher's most instructive lecture.

There was a technical scheme at present under discussion which would enable the particular work of Mr. Fletcher and his colleagues to go forward with great rapidity and give more flexibility to it. The Corporation were trying to arrange a scheme throughout Britain whereby every person could have an alternative programme. The first station was being built in London. There would be other

stations in Manchester, Glasgow and Cardiff. The Corporation would soon be able to guarantee to every listener throughout the British Isles the choice of alternative programmes.

SIR RICHARD GREGORY said there was a very great work to be done by the B.B.C. in regard to educational broadcasting if only the word "educational" could be got rid of. It was curious how the English people disliked the idea of being educated. There was quite a different point of view towards education and everything relating to it in Scotland and in Germany. The view which the B.B.C. had in inaugurating such educational talks was to inspire interest in subjects not usually included in the curricula of secondary or other schools. As he understood it, a speaker from Savoy Hill occupied much the same position as the itinerant lecturer who was brought in from time to time. Nothing but good could come from that kind of talk, assuming, of course, that it was not part of the ordinary school work. It was when one attempted to make those talks work, with the pupils set definite exercises upon them, and instructed to make notes upon them in the course of their ordinary lessons, that one was faced with certain difficulties which were obvious to every teacher. Teaching a class was very different from lecturing. It was impossible for any talk to be more than a lecture, unless one could create some new kind of attitude on the part of the teacher towards it - a teacher who was going to be a kind of transformer himself of the information given in a talk, and to use that for his own purposes in lessons.

As one who had listened-in a good deal, he could not help but marvel at the variety in the character of the programmes which were provided. A most important influence had been exerted by the B.B.C. in cultivating an appreciation of what was worth while. It could still be expected with confidence that the B.B.C. would carry on its great work by influencing the minds of all who listened-in. The B.B.C. would eventually arrive at a means of using that "voice out of the ether" to carry into the human mind thoughts of the highest type which would be reflected in human action.

MR. T. SMITH remarked that there must be hundreds of thousands of people who had no proper accommodation in which to listen-in. During the previous week there had been a gramophone concert given in Whitechapel by the H.M.V. Company which had lasted over two hours and at which 2,500 people attended. Was it not possible for the B.B.C. to broadcast operas under similar conditions, and also to provide someone to explain the opera? Was it not perhaps a fallacy to broadcast in the elementary schools during school hours? Did it not weaken the position and prestige of the teacher after the children had heard a specialist? Had not broadcasting also reduced the number of children who were taking up the cultivation of music personally?

MR. T. MAYNARD TIPFIELD, referring to one of the last speaker's points, thought teachers would rise still higher in the estimation of the school children, by being able to add to and supplement broadcast lectures. He was convinced that broadcast lessons were extremely beneficial to the school children.

MR. VAL A. BELL also felt that the teachers' prestige was not going to suffer by broadcast lectures. In fact, he had heard one youngster say, after hearing a loud-speaker: "If our teacher talked like that we would throw tomatoes at him." Certain lectures could be of enormous benefit to the scholars. As Educa-

tional Adviser at Wandsworth Prison, he testified to the great benefit of wireless. He had been surprised to get requests from many men there that certain books, of which they had heard over the wireless, should be put into the library for their

Miss C. Cook (Mass., U.S.A.) thought the lecturer would agree with her that the further away we got from general recreational broadcasting towards the more educational type of broadcasting, the nearer we came to a very dangerous line of distinction between what was education and what was propaganda. She would like to know how the scientific, unbiased character of the broadcasting such as Mr. Fletcher had described was to be guaranteed.

Mr. George Fletcher thought that perhaps Captain Eckersley had produced a wrong impression upon the audience. It would be absurd to suppose that Captain Eckersley was not enthusiastic in the matter of educational broadcasting. Captain Eckersley believed in the great cultural value of broadcasting, and in a broad cultural education; he only objected to the labelling of that as "education." There was an absence of any reference in the paper to one matter which lay very close to his own heart and conscience. He had spent part of his life in teaching and in administering education in remote rural districts. This country still had before it the problem of keeping people on the land and retarding the influx of people from the land to the large towns, already too crowded. Yet he had to declare that if he had to live, especially in winter, under conditions which characterised many of the rural districts of these islands, he should long for the glare of the city and the jazz band. It did not follow that one should seek to give to the people in remote rural areas - indeed, it would be a shocking abuse of our responsibilities to do so—the glare of the city and the jazz band even if it were possible. The problem now, as always, was how to improve the amenities of the countryside and to facilitate cultural influences which need not be labelled "Education"—and in such work broadcasting was an agent of the first importance. He remembered discussing this problem with members of the United States Government twenty-three years ago, who had the same problem to face—that of keeping people on the land. At that time the authorities sought to introduce the telephone into most out-of-the-way rural districts in order to give the people there a little of social contact. Every rural district in this country should have a village hall in which there was a receiving apparatus. He hoped by the alternative system, to which Captain Eckersley had referred, a programme would be issued which would give such people both amusement and education; he was convinced that there were many people in rural districts who would much prefer the latter to a jazz band.

The Lecturer, replying, said that they must not take Captain Eckersley too seriously—sometimes he (Captain Eckersley) was like the orator who said, "Before I begin to speak I want to say a few words." Captain Eckersley had said a few words—and the Lord had delivered him into his hand.

Captain Eckersley had no use for formal education—yet he spoke French fluently—more than a little German, and was a distinguished engineer. When they taught him these things did they call them by any other names? The B.B.C. did not lay emphasis on the intrinsic value of its broadcast educational matter—on the other hand, it did not insult the intelligence of its listeners by wrapping up what was instructive and interesting like some sort of sugar-coated pill.

If there were people who supposed that because a talk was instructive—was educative—it was therefore boring, then perhaps the B.B.C. might be the means of demonstrating to them that it was not so, and might cultivate a taste for deeper enquiry into matters worthy of serious study. It was at that that they aimed.

Besides, the B.B.C. did not force education upon people—no one was under compulsion to listen—there were alternative programmes. But there were many people who wanted to learn, as was shown by the sale of educational text books.

Referring to Miss Cook's remarks, Mr. Fletcher went on to say that it was not a question of getting away from recreational broadcasting down to broadcasting which was labelled "education" as such. Nobody could seriously consider the problems which faced this country to-day and honestly say that one could teach people the things they had to get to know in order to live and move in this world and yet pretend that it was anything else but education. Why try to get away from the fact? The B.B.C. recognised the importance of guaranteeing the "scientific" unbiassed character of the educational matter broadcast. They had set up two Central Councils representative of all the prominent authorities concerned, and the teaching profession itself was well represented.

He did not think that broadcast lectures would weaken the position of the teacher. The best guarantee of that was what the teachers themselves said, and in this connection he drew the attention of the audience to what the head of a men's evening institute in the East End of London had said: "You are doing one very important thing for us. You are putting us in touch with first-class scholarship and opinion, thus invigorating us, and particularly me, in our efforts. The danger of all schools—and ours is a school, of course—is dust, mental dust. You are throwing open the windows for us and giving us draughts of fresh air."

Sir Richard Gregory had touched on a point which he would like to have elaborated, namely, the vital importance of broadcast matter in stimulating further interest and study. If that was not the beginning and end of what the Corporation was trying to do, it was something very like it. They were trying to do two things. They were trying to bring fresh voices into schools, and they were trying also to stimulate an interest in subjects which the average individual could not get in the environment in which he or she was ordinarily placed.

A hearty vote of thanks to the lecturer concluded the meeting.

NOTES ON BOOKS.

Practical Color Photography. By E. J. Wall, F.C.S., F.R.P.S. London: Chapman & Hall, Ltd. 15*s*. net.

This is the second edition of an American manual which has been in wide use since its first appearance in 1922. While the theoretical side of the subject is somewhat meagrely treated, the practical details are particularly full and intelligible, and include summarised working instructions for almost every known process of colour photography.

The paucity of systematic explanation of the principles on which the various methods are based, while resulting from the author's deliberate decision, is nevertheless to be deplored. Not only is a clear general view of the subject thereby rendered unnecessarily difficult to obtain, but even the most practical instructions are much harder to grasp when their ultimate purpose is obscure.

Excluding one or two interesting but quite unpractical processes, it may be explained that the "colours" in a colour photograph consist of dye-stuffs suitably disposed; the problem being so to arrange matters that these dyes are laid down in the final transparency or print in such a manner as to produce, to the eye of an observer, a chromatic effect comparable with that of the original object. Technical imperfections apart, this can in theory be effected by the use of only three different dyes. It is true that the resulting colours may be very different in physical constitution from the originals, and that a spectroscope might not be deceived for an instant by the imposition; but the eye is not a spectroscope, and all that is necessary is that it should be suitably stimulated.

The practical processes in use for building up the final picture fall into two fundamentally different classes, the subtractive and the additive. In the former, the picture consists of three superposed transparencies, each transparency being stained with one of the three dyes already referred to. White light traversing the combined picture was to run the gauntlet, so to speak, of all three dyes in varying depths of intensity; at each film it will lose some of its original colours, and its final hue, as it reaches the eye, will thus be determined by the relative densities of the three coloured films it has traversed.

The additive process is very different. Here, as a general rule, we produce a mosaic of very minute spots, each spot being stained by one only of the three dyes, so that from any small area of the picture the eye receives a group of minute light-pencils of the three colours in question. Which will predominate, however, will obviously depend on the relative numbers of the differently coloured spots in the area; and since the spots are far too small to be visible individually, it is evident that a blending will occur in the eye, and that any desired hue can be given to the area by proper adjustment of these relative numbers.

An important theoretical difference between the two classes is that in viewing a subtractive picture one sees light which has passed through three coloured films in succession; whereas in an additive picture all the coloured grains of the mosaic lie side by side, and no pencil of light has to penetrate more than one. It is not difficult, therefore, to imagine that the three stains used in the first process have to be totally different in colour from those used in the second, if similar chromatic effects are ultimately to be produced.

The author begins with methods founded on the subtractive principle, and describes how the process starts with the production of three negatives, taken through three differently coloured screens. The exposures may be made simultaneously, using a single lens, in a special camera; or successively, using an ordinary camera; or again one may use a "tri-pack," which consists essentially of a pack of three films, practically in contact, of differing colour-sensitiveness, and separated by colour-screens.

Next are described the great variety of processes by which the coloured transparencies are produced from the three respective negatives, full practical details being given in almost every case. Though these details differ very widely, the methods approximate in principle either to the gum-bichromate or to the carbon process, as used in monochrome photography.

Turning to the additive processes, we find that these are represented almost entirely by the so-called "screen-plates," of which the best-known example is the Autochrome. The mosaic, to which reference has already been made, is produced in several different ways. In the Autochrome, brightly-dyed starch grains, of three different colours, are mixed in such proportions as to form an apparently colourless heap, which is then spread over the the film in a layer one grain thick; in other

screen-plates, a coloured geometrical pattern of minute spots is printed mechanically. It is to be noted, as an interesting feature of screen-plates, that the coloured light-filters, through which the emulsion is exposed, are thus the actual spots of colour which compose the final picture.

The author does not confine himself to methods which are commercially practicable; and some of his most interesting chapters deal with so-called "laboratory processes" which can never come into popular use. Included in this group is the beautiful device of Lippmann, in which the colours are produced by optical interference or diffraction.

A final chapter is devoted to cinematography in colour. Although this problem presents difficulties of its own, it opens up the possibility of two additive processes, both differing essentially from anything so far described. In one of these, three images of different colour are projected simultaneously, through three lenses, on to the same screen; in the other, which also fulfils the additive condition, though in a peculiar manner, red, green and blue-violet pictures are projected in regular rotation. Each image, of course, persists long enough on the retina to be blended with its successors in the familiar cinematographic fashion, and the effect produced is one of normal colour. This particular method, however, amongst other disadvantages, has that of frequently producing severe headache in the observer; and since all the alternative processes suffer from defects and difficulties of one kind or another, the author is certainly justified in remarking that "cinematography in colours is hardly within the purview of the average amateur."

A History of British Water Colour Painting. By H. M. Cundall. London: B. T. Batsford, Ltd. 25s. net.

Holbein introduced the miniature into this country, and a Fleming, Wyngaerde, familiarised our artists and patrons with the tinted topographical drawing. More important was the influence of Wenceslas Hollar in the seventeenth century. Hollar was brought over by that famous Earl of Arundel to whom Van Dyke owed so much, and of whom Rubens painted the admirable portrait that is in the National Gallery.

It was a long time before landscape painting in water-colour broke away from the topographical tradition. The old technique was admirably used by Rowlandson for caricature, and the new technique foreshadowed in the work of Alexander Cozens and Paul Sandby, rival candidates for the title of "father" of English water colour. Angelica Kauffmann, too, though principally a painter in oils, did interesting drawings in wash.

Richard Wilson and Gainsborough struck the fetters from the art of water-colour. Their followers, in the more restricted sphere, were J. R. Cozens and Thomas Girtin, who, contenting themselves with a relatively narrow scale of colours, cultivated a modest naturalistic manner. Turner was more ambitious, and showed no less dash in water-colour than in oils. His extraordinary evolution of style is demonstrated by three plates in Mr. Cundall's book, of which this is the second edition, revised and enlarged. Waltham Cross, plate XII, illustrates the early phase, in which Turner's colours were sober and his designs often excellent. Hastings, plate XIII, belongs to his middle period, and bears a strong resemblance to his animated sea-pieces in oil in the National Gallery. The Lake of Thun, plate XIV, has the interesting but exasperating characteristics of the famous Petworth Interior.

At any rate, here we have the possibilities of water-colour at last properly explored.

Henceforward every painter who had individuality managed to express his personal vision in this medium. Mr. Gulland's selection of plates could hardly be better for illustrating the point. In water-colour as in oil the nineteenth century painters formulated their mysticism, romanticism, sentimentality; their scientific dogmas, their faith in æsthetic or non-æsthetic principles. From Constable and Samuel Palmer to Whistler, *via* the Pre-Raphaelite Brotherhood, the record is complete. On the whole one feels that the weaker the artist the more he is exposed by his work in water-colour, and the stronger he is, the more interesting is the analysis of his method afforded by his experiments with the less noble medium.

The author concludes with a chapter on the New English Art Club. The short biographies of artists are valuable; and it need hardly be said that Messrs. Batsford have produced the book in a worthy manner.

SPANISH GARDENS. By C. M. Villiers-Stuart. London: B. T. Batsford, Ltd. 25*s*. net.

There are three sorts of ideal garden, and all three types have their charm. In the Gothic or sentimental ideal, the garden appears to have grown up naturally, without human intervention; even the honeysuckle looks as if it had enlaced the old cottage spontaneously. In the classical ideal, the formal garden is a middle term between architecture and free nature: it compromises between the exact design of the house and the indiscipline of the fields and woods. In the Iberian ideal, house and garden are one. There is one word, *carmen*, for the two together. They are designed simultaneously, and are interdependent.

The Moorish princes whose dazzling *regime* was overthrown by Ferdinand and Isabella were passionately fond of gardens; to this day Spain adheres to their system of planting. The Moslem had a leaning for geometric pattern which corrected or strengthened his love of the luxurious and the exotic. But the baroque, whether house or garden, has always been spiritually at home in Spain; the Egypto-Byzantine baroque of the Ommeyads; the Gothic-Burgundian baroque, or Mudejar, of the Catholic Monarchs; the Italian baroque of the Renaissance, in which all Spain was rebuilt. For this reason, while giving the Moors full credit for their actual achievement, we must not make too much of their influence; we must acknowledge a debt to the sun and the soil.

Nevertheless, more than half of Mrs. Villiers-Stuart's book is devoted to Moorish gardens and sites; and half is not too much. The grand manner of the Moors was based on a foundation that is next best to intelligent humanism: on a coherent cosmogony. The paradise-garden was the earthly replica of Paradise itself. Just as we are given to understand that there are seven chambers in Heaven, so do we learn that in the Moslem Paradise there are eight Pearl Pavilions: hence the eight glorietas in the gardens of the Alcazar, and the glorieta system generally.

But no antithesis need be sought—none will be found—between classical humanism and the spirit of the Spanish gardens. What distinction there is, so far as expression is concerned, is one of degree. The gardens were to be comfortable, interesting and beautiful. The garden architect's patron, it was borne in mind, was neither a god nor a machine, but a man of sensibility and sophistication.

Look at plate LIV: La Granja de Fortuny. Who would not sooner retire to this lovely spot than to one of the dehumanised villas of the machine age? The garden follows an ancient Moorish plan, and with its waterfalls and terraces of orange groves is an exquisite example of that romantic type of design that is only carried out when man and nature are in perfect collaboration. P.B.

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FRIDAY, JULY 26th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

COMPETITION OF INDUSTRIAL DESIGNS.

A selection of the Designs received in the above Competition for Prizes and Scholarships offered by the Society and well-known manufacturers will be exhibited, by kind permission of the Board of Governors, in the Exhibition Pavilion of the Imperial Institute, South Kensington, from the 3rd of August to the 1st of September next, every weekday from 10 a.m. to 5 p.m. (Sundays 2.30 to 6 p.m.)

The Exhibition is open free of charge; no tickets are required. It will include Designs for Architectural Decoration, Textiles, Furniture, Printing and Book Production, Pottery and Glass, and for Posters, Showcards, etc.

Several important firms have expressed a wish to offer Prizes for Designs in connexion with the 1930 Competition.

A Bureau of Information has been established at the Royal Society of Arts in connexion with the Competition, for the registration of the names and addresses of exhibitors who desire to obtain employment as designers. These lists are at the service of manufacturers in search of designers.

A report on the competition, including full lists of awards, will be published in the *Journal* at a later date.

REPRINT OF CANTOR LECTURES.

The three Cantor Lectures on "Biology and Refrigeration" by Dr. Franklin Kidd, M.A., D.Sc., recently published in the *Journal*, have been reprinted in pamphlet form (price 2s. 6d.) and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can also be had on application.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 10TH, 1929.

SIR RICHARD A. S. PAGET, Bart., in the Chair.

The following paper was read :—

SOME MODERN ASPECTS OF ELECTRICAL COMMUNICATION.

ADVANCES IN TELEGRAPHY AND TELEPHONY

By G. H. NASH,

European Chief Engineer, International Standard Electric Corporation.

In order that some of the more modern aspects of electrical communication may be followed with clarity, it will be desirable first of all to take a broad view of the major elements that enter into the modern telephone or telegraph communication system, but before taking this broad view it may be well to remind ourselves that this lecture before the Royal Society of Arts is only one of many previously delivered in this building.

The Royal Society of Arts has encouraged electrical communication from its earliest stages, and as long ago as 1856 the word "telephony" appeared in the *Journal* of the Society, when it was applied to a method of transmitting musical sounds. One of the most important contributions to the subject in the *Journal* was the account on November 30th, 1877, by Professor A. Graham Bell himself, of the articulating telephone, on which occasion the harmonic character of alternating currents was for the first time revealed and recognised. Also, in many lectures particular aspects of communication by wire have been dealt with; amongst others I would mention submarine telegraphy, the Hughes type-printing telegraph, and the D'Arlincourt method of transmitting writing.

Again, in successive Cantor Lectures, the story of Hertzian wave telegraphy has been told, and one of the most recent lectures on this subject was that given by Senator Marconi, when he described the results of his experiments with Beam Transmission.

The purpose of the present lecture is to discuss some of the lesser known problems which arise on very long distance telephone connections, and to explain how, by modern methods of telegraphy and telephony, a number of communications can be made simultaneously over a single pair of wires without interference. Therefore, for the purpose, I have had prepared a diagram

(Fig. 1) which shows the main links in a long telephone connection between two subscribers over two continents and including a transoceanic radio link, and I will describe briefly the various stages of such a connection, and, in passing over them, refer in some cases to recent improvements.

The diagram, as you observe, shows the complete connection from telephone subscriber to telephone subscriber in which is included, first the private branch exchange, then the automatic exchange, then the trunk exchange, then the two-way repeater on the trunk line, then the distant trunk exchange, then the technical operator's position controlling a wireless link, and so on through a similar train to the distant subscriber.

Reviewing this diagram step by step, it may be advisable first to say a few words about the subscriber's set which, extraordinary as it may sound, has not received its fair proportion of scientific thought and investigation when compared with practically all the other equipment shown on this diagram.

The subscriber's set, as the sensory organ of the telephone system responding to the sound waves emitted by the speaker and ultimately converting the received electrical currents into sound waves by means of the receiver, is one of the most important parts of a telephone connection ; since there is no change quite so radical as the conversion of sound energy into electrical energy, and *vice versa*, for no telephone system can be possible without the means of doing this.

The subscriber's set has, however, to do a good deal more than act as the speech and hearing organ of the telephone system ; it has also to act as the nervous system, inasmuch as it calls attention by the ringing of the bell to an incoming call, and it attracts the attention of the exchange operator when an outgoing call has to be made. Still more than this, in the case of a set connected to an automatic exchange, the dial by the manipulation of which the complete automatic connection is set up may be regarded as equivalent to the motor centres of the brain. All these functions have to be performed by the ordinary telephone user, and everything must, therefore, be simple, so that there may be no difficulty or confusion arising when an individual uses the telephone rarely, or even for the first time; in other words, the telephone system has to be placed within the reach and control of the subscriber, it has to be operated (in the case of automatic telephones) by the subscriber, and yet with such simplicity that it is kept in operation in spite of the subscriber.

The model on the table illustrates a modern telephone subscriber's set. The hand-set, or telephone instrument proper, will be recognised at once as being more convenient and comfortable to use than the pedestal-type telephone which has been in use in this country hitherto, although the pedestal instrument was reliable and efficient.

There have been many difficulties to overcome in producing hand-sets which would give the same degree of reliability of service as can be obtained from the pedestal type of set. These difficulties have arisen mainly from the fact

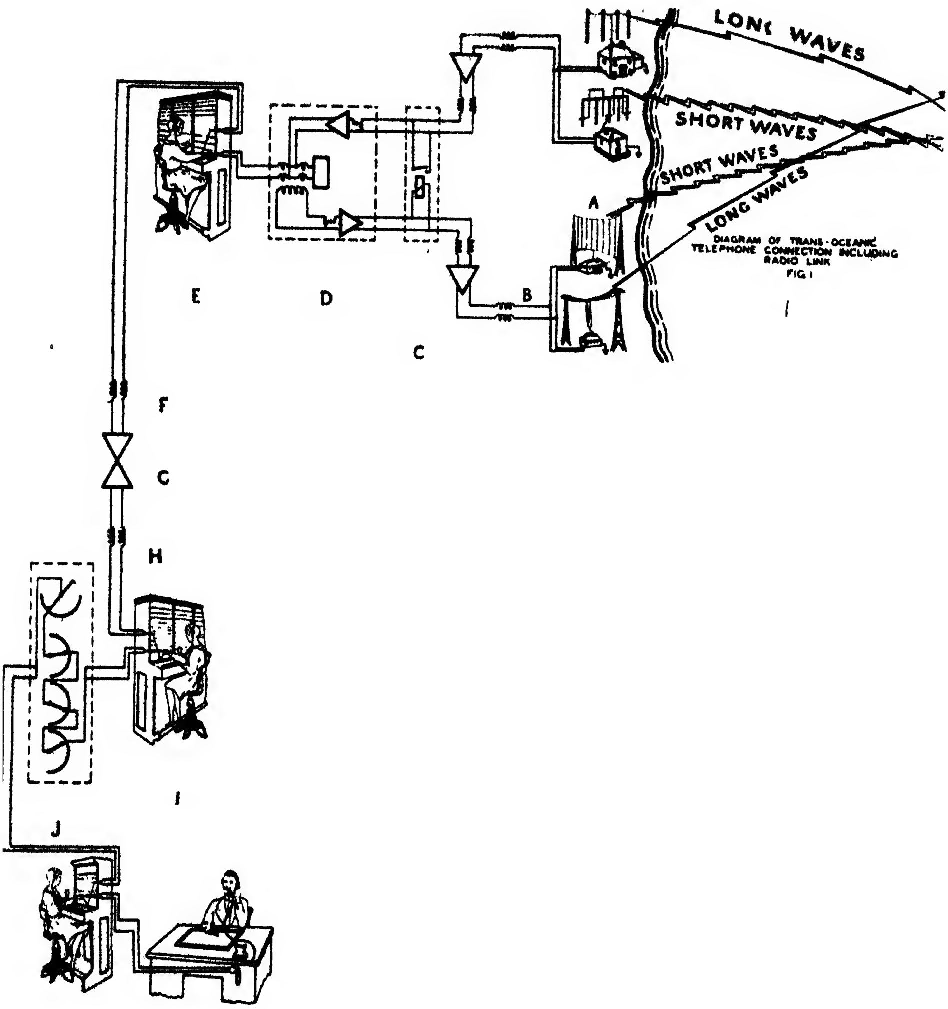


FIG. 1.—A, Radio Stations; B, One-way Amplifier; E, Long-distance Trunk Exchange; F, Loading Coil; G, Two-way Repeater; K, Local Private Branch Exchange; L, Subscriber.

that in a combined instrument of this type the talking distance of the mouth from the mouthpiece is determined by the size of the speaker's head, since it will readily be realised that the telephone must be placed on the ear and, consequently, the mouth cannot, as a rule, be approached closely to the transmitter; this has made it difficult to secure adequately loud speech in all cases. The other main source of difficulty has been intimately associated with the one particular characteristic advantage of hand-sets; that is to say,

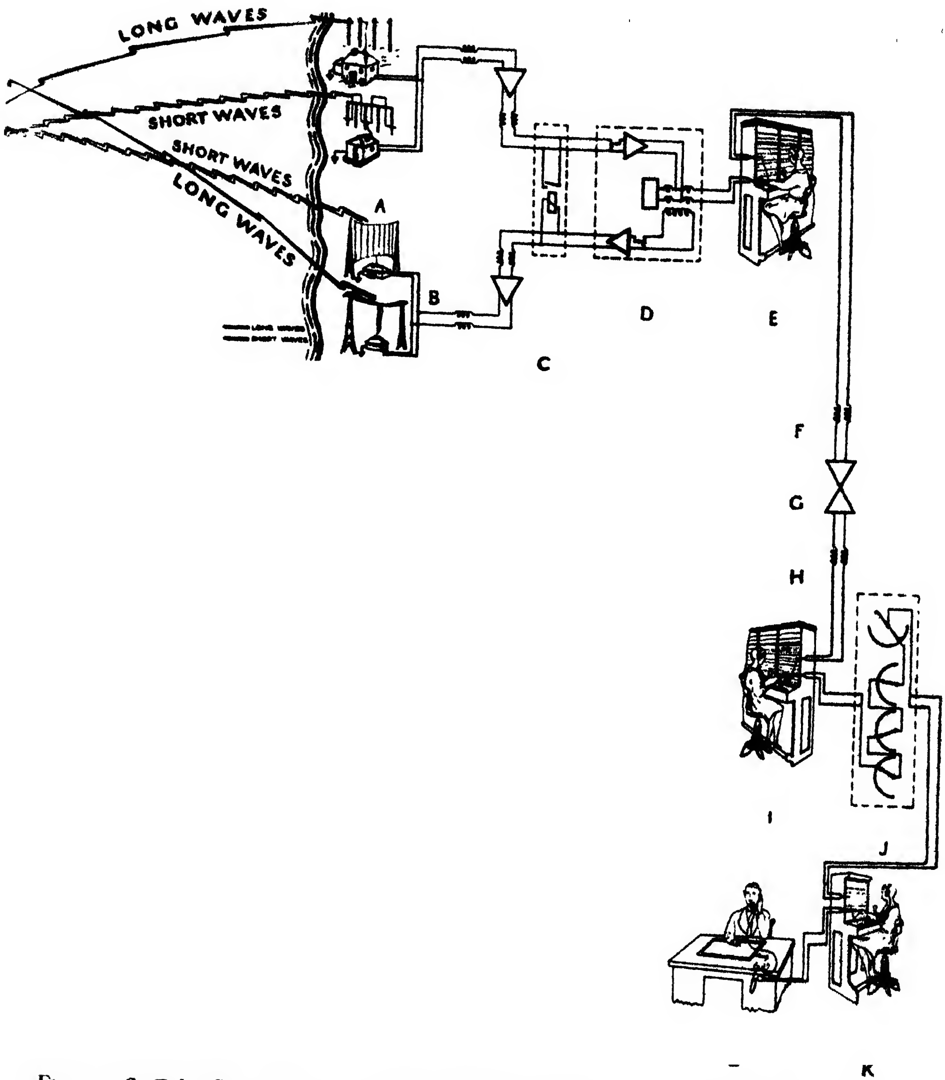


FIG. 1.—C, Echo Suppressor; D, Technical Operator's position; H, Loading Coil; I, Local Trunk Exchange; J, Local Automatic Exchange.

the entire freedom of movement which the user enjoys enabling him, for example, to lean back in his chair in a comfortable position rather than to sit up stiffly in front of the fixed transmitter; thereby it has been necessary to find a transmitter capable of functioning in almost any position, and this has been surprisingly difficult as will, perhaps, be understood when one considers that the transmitter contains loose granular powder between electrodes, and that it is essential for the operation of the apparatus that the powder should be loosely distributed and not packed tight.

Passing from the hand-set the call passes through a private branch exchange which is probably familiar to most of you and, in any case, involves no particularly new feature, and from thence to an automatic system. A model will be demonstrated after the lecture of an automatic system which is somewhat similar to the type of automatic system being installed in this country by the Post Office.

The means by which the subscriber obtains the attention of another consists in the main of an electro-magnetically controlled mechanism known as the "Selector." This mechanism has associated with it an electrical circuit containing relays and electro-magnets, and is capable under the direction of electrical impulses of stepping its shaft both vertically and horizontally, and also effecting a release to normal. Normally the mechanism is arranged for ten steps in each direction.

If, then, there is attached to the shaft an arm with a wiper, it is possible for this arm to be directed to any point in a field or bank of 100 contacts arranged in arc corresponding to the rotary sweep of the wiper. This is the simple case of the Step-by-Step System, and would enable a subscriber connected to the wiper to reach any of 99 other subscribers.

In practice a subscriber is given a dial which is capable of being rotated to the required number and on its return journey interrupts the circuit, thereby supplying impulses to the selector. Two operations of the dial are necessary to give the selector vertical and then rotary motion to the required line.

To enable any subscriber to call another in the 100 line case, it is clear that each would require a selector, an obviously impossible economic scheme. Selectors are only provided in practice to cater for the greatest probable number of simultaneous conversations; hence the number of selectors is much less than 100. In order to connect 100 subscribers to a less number of switches, each subscriber has a rotary line-switch which has wired to its arc, trunks to each selector. When a subscriber removes his receiver, the line switch instantly hunts for a free trunk and the subscriber proceeds to dial his two digits into the selector, which connects him to the required party and applies ringing to his line. After conversation the line switch and selector return to normal.

From the automatic exchange we will pass to a trunk exchange.

The operating procedure with long-distance traffic which is handled at the trunk exchange, differs considerably from that at local manual exchanges. Long trunk lines are very expensive, and, except when long distance telephony is well developed, it is not economically possible to provide sufficient lines so that subscribers requiring a long distant call can be connected without delay—at least during the busy day period. Service is provided on what is termed a delay basis, the delay depending upon the number of calls waiting for a free line. Calls to the trunk exchange must therefore be recorded and the tickets given to an operator who takes each in rotation as the trunk line is free.

The trunk exchange, therefore, is provided with a recording switchboard

where the operators receive the request for a call from the subscriber *via* his local exchange, note the details on a ticket and advise the subscriber that he will be called when the connection has been set up. Special arrangements have to be made to distribute the tickets to the trunk line operators, and it is the duty of a distributing operator, who knows the positions dealing with a particular trunk line, to forward these tickets. When the distributing operator's positions are in the same line as the recording switchboard a very satisfactory and largely-used method of conveying the tickets from the record position to the distributing operator is by means of a belt conveyor.

At the distributing position the tickets are sorted and sent to the particular trunk line position concerned. Some form of pneumatic tube equipment is usually provided for this purpose. The distributing operator is provided with a series of sending valves connected to tubes ending in receiving valves at the various trunk operators. The ticket is inserted in the appropriate sending valve and delivered to the line operator, where it is placed in order of its priority. Each trunk line operator has also a sending valve connected with a tube to the distributing operator, so that when the call has been completed the operator may return the ticket to be marked with the appropriate charge, then sorted and filed ready for the account to be made up.

The return tubes from the line positions are usually common to a line of switchboards and end in a receiving valve at the distributing position. For the system shown the tickets are delivered under pressure from the distributing position to the line position, and by means of suction from the line position to the distributing and filing position.

It will be appreciated also that it may be necessary to connect together two trunk lines at a trunk exchange. Special positions are provided for this purpose, and if an incoming call is received for connection to another trunk line, arrangements are provided for transferring the call to the special through position. It is often necessary when two trunk lines are connected at a through position, to insert a repeater in the circuit so that speech will be audible over the whole circuit. For this purpose there are provided cord circuits with repeater equipment connected thereto, so that any two lines may be connected together through a repeater. Such an equipment is known as a cord circuit repeater.

Where long-distance telephony is more highly developed a sufficient number of lines can be provided to supply a no-delay service. The recording switchboard is then abandoned and a method of operation known as the combined line and recording method is introduced. In this method the trunk line operator receives the call from the subscriber and makes out the ticket, but the subscriber does not hang up and wait to be called. Instead, the line operator completes the call to the required subscriber and connects the two together with little or no delay. The ticket is then stamped in the usual way. This saves recording

positions and a good deal of ticket distributing equipment, and gives, of course, a much faster service.

Where trunk exchanges are used in automatic areas the trunk line positions are often fitted with a dial for automatically connecting to the required local subscriber. In some modern trunk exchanges also automatic equipment is used extensively for inter-connecting between different positions and also for automatically distributing incoming calls to the recording position. Here the operator has merely to operate a key to be put in connection with a calling subscriber and takes the particulars of his call.

If the calls, instead of going to the distant trunk exchange and so on to the local subscriber, have to pass through a radio link, these calls are passed to a special position equipped with the necessary apparatus for the purpose and operated by a technical control operator. For the purpose of the lecture however, it will be assumed that a radio link is involved. As is well known, the Atlantic radio link operating between this country and America is the only official channel for telephone communications existing between the old and the new world.

The Rugby Radio Station is situated about 4 miles south-east of Rugby and occupies a site about 1½ miles long by 1 mile wide.

The station buildings are erected at about the middle of the site. These buildings also accommodate the high power telegraph transmitter used for the Imperial Wireless Service. The aerial is supported on twelve masts, each 820 feet high, and is so arranged that it may be divided into two sections. The telephone transmitter uses one section only.

The masts are insulated at the base. Twelve columns of porcelain insulators are placed immediately below the pivoted joint of the mast, the whole being supported by a granite block and a steel column. The mast can be raised by hydraulic jacks in case it is necessary to replace any faulty or damaged insulators.

The transmitting equipment can be divided broadly into four parts, namely, the low power or "sideband" equipment which produces the single sideband of radio frequency, the power amplifier which amplifies this to the value required for transmission across the Atlantic, the output tuning circuits, and the control table.

The sideband equipment comprises apparatus for controlling and amplifying the voice currents received from the telephone line, oscillators and modulating apparatus which convert these voice currents into a single sideband of radio frequency and the first stages of amplification necessary for amplifying the latter up to a power level of about 50 watts. The above apparatus is mounted on four panels installed in a special room entirely shielded with copper gauze.

There is a control table from which position the operator on duty is able to control the whole station. Behind the control table are two power amplifier units, each consisting of fifteen water-cooled valves. This is the final stage of

amplification capable of delivering an output of 300 K.W., which is equivalent to 400 h.p. Two earlier stages of amplification, the first employing one water-cooled valve and the second employing three water-cooled valves, raise the output from the sideband equipment to the power level required for driving the final amplifier.

The receiving station on this side of the Transatlantic Radio Link is installed near Cupar, in Fifeshire. Two receiving sets are in operation.

Directive reception is employed in order to eliminate unwanted signals. The system used consists of six large loops each of them supported on two 130-ft. steel towers placed 200 yards apart. The loops are situated at distances up to three miles from the receiving station. By correctly placing the six loop systems and combining their outputs very few signals are received from any direction other than from Rocky Point.

As a supplement to the long wave Transatlantic Link a short wave circuit is now in operation, so that two circuits are available during most hours of the day. The short wave transmitter at present in use at Rugby is an experimental set.

From the transmitting station we pass by means of wireless waves to the receiving station on the other side of the ocean and from this stage the various links are identical in nature with those already described.

Now, very long distance telephone connections of this kind, or similar connections which may only involve aerial and cable circuits exhibit certain effects (which are present to a negligible degree in shorter circuits) and special steps have to be taken to mitigate them. These effects are :—

(*a*) Attenuation distortion
(*b*) Phase distortion
(*c*) Echoes
(*d*) Interference

(*a*) *Attenuation distortion* sometimes called frequency distortion, refers to the variation of the attenuation or power efficiency with frequency. An unloaded cable is a prolific source of such distortion, the attenuation increasing rapidly with frequency. The method of loading cables, commonly practiced, by the insertion of lumped inductances at intervals of about six thousand feet, causes the attenuation to remain relatively low over the most important part of the speech range, after which it rises to a value higher than in the absence of the loading. This results in a reduction of distortion over the essential part of the speech range, but in certain cases the residual distortion may still be intolerable.

Attenuation distortion may be removed by the association of suitable resistance—reactance networks with the circuit ; these are usually referred to as attenuation equalisers and introduce loss at the frequencies where the line loss is low so that the sum of the line and equaliser loss approximates to a constant value for all frequencies transmitted. In certain cases the

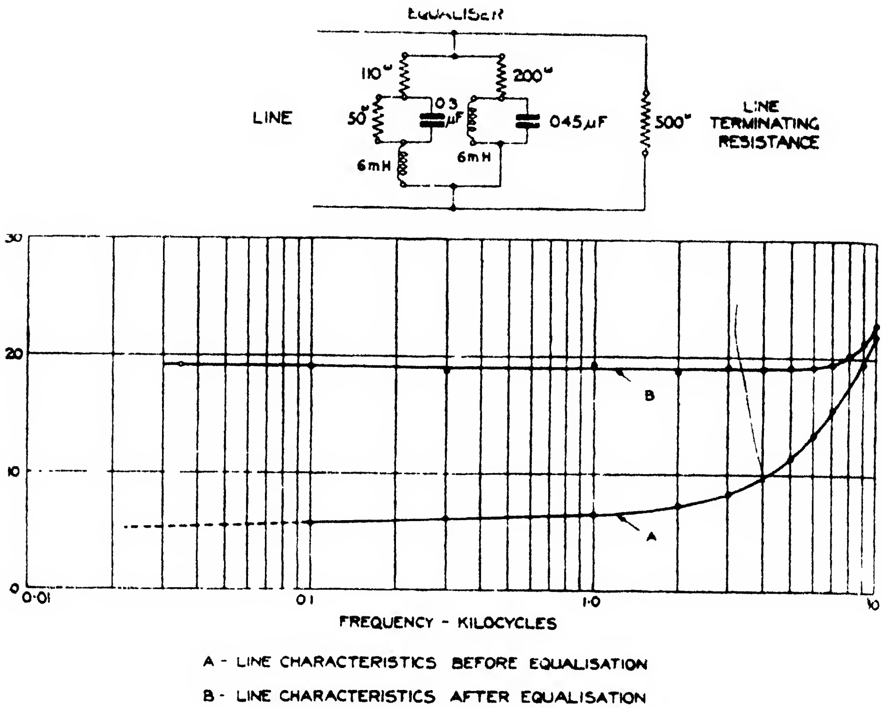


FIG. 2.

reactances and capacities associated with the transformers of the amplifier constituting part of a telephone repeater may be adapted to supply the necessary equalisation ; this method has found favour in toll cable practice on account of its obvious economy.

Long distance circuits are of course not exclusively confined to the transmission of speech, and may be used for broadcasting or other purposes such as picture transmission.

As an example of the ease with which equalisation can be carried out over a comparatively wide frequency range, Fig. 2 shows the measured attenuation of a special broadcasting circuit before and after equalisation, together with the equaliser which was used for the necessary compensation.

(*b*) *Phase distortion* is introduced by the difference in time of travel for different frequencies ; it derives its name from the fact that the time of travel depends upon the way in which the phase shift of the complete system varies with frequency. The statement by Helmholtz that relative phase shift of different frequencies is not important applies only to steady tones and breaks down when the conditions are so extreme that parts of a finite wave envelope starting at the same time arrive at the receiving end at different times, and when the difference in the time of arrival is greater than 30 milliseconds.

In practice, for long distances, loaded cables having a higher cut-off are

generally used so that phase distortion does not become serious until appreciably higher frequencies are reached and it is automatically eliminated by the fact that the repeaters normally used do not pass the frequency range above 2,400 cycles. For two wire circuits, high cut-off cables have the additional advantage that their speed of propagation is greater, which makes echoes less harmful, their impedance is more uniform within the pass range which facilitates the construction of balancing networks, and their attenuation distortion is so small that very little correction is necessary. As an alternative to the use of high cut-off circuits the use of time delay correcting networks in an analagous manner to attenuation equalisers, has been proposed. These networks are either of the lattice or bridged T type, arranged so that they build up the time of travel of the fastest frequencies (*i.e.*, the low frequencies in this case) to be as nearly as possible equal to the time of travel of the slowest frequency in the pass range of the system.

(*c*) *Echoes* are caused either by the return of part of the speech energy to the talker after an odd number of reflections, or by subsequent repetitions of the speech arriving at the receiving end after an even number of reflections. The term "reflection" is here intended to include any event during the process of which the original speech currents give rise to currents having the direction of propagation reversed.

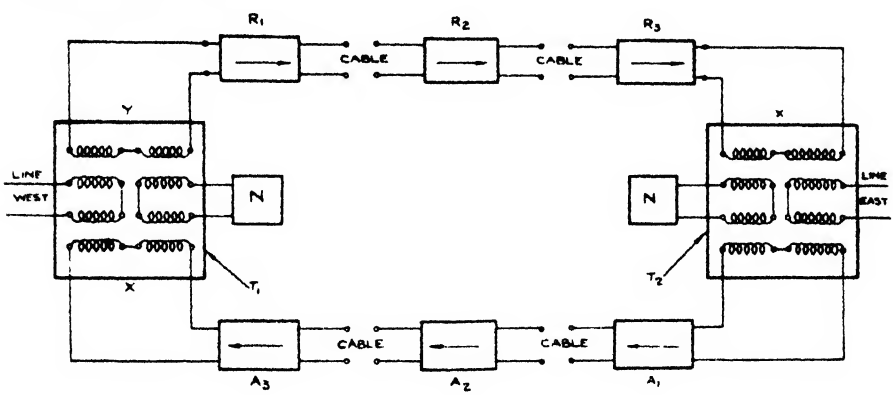


FIG. 3.

Fig. 3 shows a type of long distance circuit in which a separate pair of wires is provided for talking in each direction; this is usually referred to as a four-wire circuit. R_2, R_1, etc., and A_1, A_2, etc., are one-way amplifiers compensating for the attenuation in the associated cable lengths. T_1 and T_2 are terminating sets which behave effectively like Wheatstone Bridges, so that if the networks N balance exactly the impedance of the associated line, respectively west or east, then currents introduced at X produce no effect at Y, but only transmit speech out west or east, as the case may be. In practice, however, exact balance is never obtained, and a fraction of the current introduced at X appears

at Y and returns to the talker after one reflection attenuated by twice the equivalent of the circuit plus the loss across the terminating set. It returns to the listener after two reflections attenuated by three times the attenuation of the circuit and the sum of the losses through two terminating sets. In this way an indefinite number of separate echoes may arise, but subsequent repetitions in circuits having normal equivalents are so attenuated that considered individually they are not of serious practical importance.

In the case of a two-wire circuit each individual repeater has two balancing circuits associated with it, each of which affords the possibility of reflection taking place; but the reflection occurring at the terminals of the system is the most serious, because the balance there is always worse than at any other point in the circuit. This is on account of the fact that the end of the system has to be connected to a variety of circuits varying comparatively widely in impedance.

In order to eliminate terminal echoes it is usual to provide some means by which speech currents travelling through the circuit in one direction block the circuit operating in the other direction. This can evidently only be done at a point in the circuit where four-wire operation occurs. In the case of a two-wire system the circuit is in effect converted to a four-wire circuit at every repeater in order to permit the insertion of one-way amplifiers. For this reason, and because the highest levels are obtained in the output of repeaters, echo suppressors, whether of the relay type or grid-jamming type, are always associated with repeaters

Fig. 4 shows a typical arrangement for echo suppression used by the International Standard Electric Corporation on four-wire systems. The top and bottom blocks may be considered to represent amplifiers occupying positions in a circuit similar to A_2 and R_2 in Fig. 3 The middle blocks constitute the echo suppressor, which exists in two halves identical in function and differing only in the arrangement of their filament circuits to afford the most economical disposition. Referring to the top half of the echo suppressor, valve 8 is an amplifier bridged across the output of the amplifier in line 2-2′. This valve applies the amplified speech voltages to the input of valve 10, which serves as a voltage limiter, and within the working range makes the behaviour of the apparatus substantially independent of speech level in the line The output of the limiter is applied to valve 13, which rectifies the speech currents, causing a direct current to flow in resistance 14; within the operating range of speech levels, this current, owing to the effect of the voltage limiter, valve 10, is, to all practical intent, independent of the speech level at 2′. The voltage generated across resistance 14 applies such a negative voltage to the grid of the second valve that its amplification is converted into a loss.

In this way speech in line 2 2′ paralyses the circuit 1-1′, so that any echoes are rendered ineffective.

A special type of voice operated switching device is employed in connection

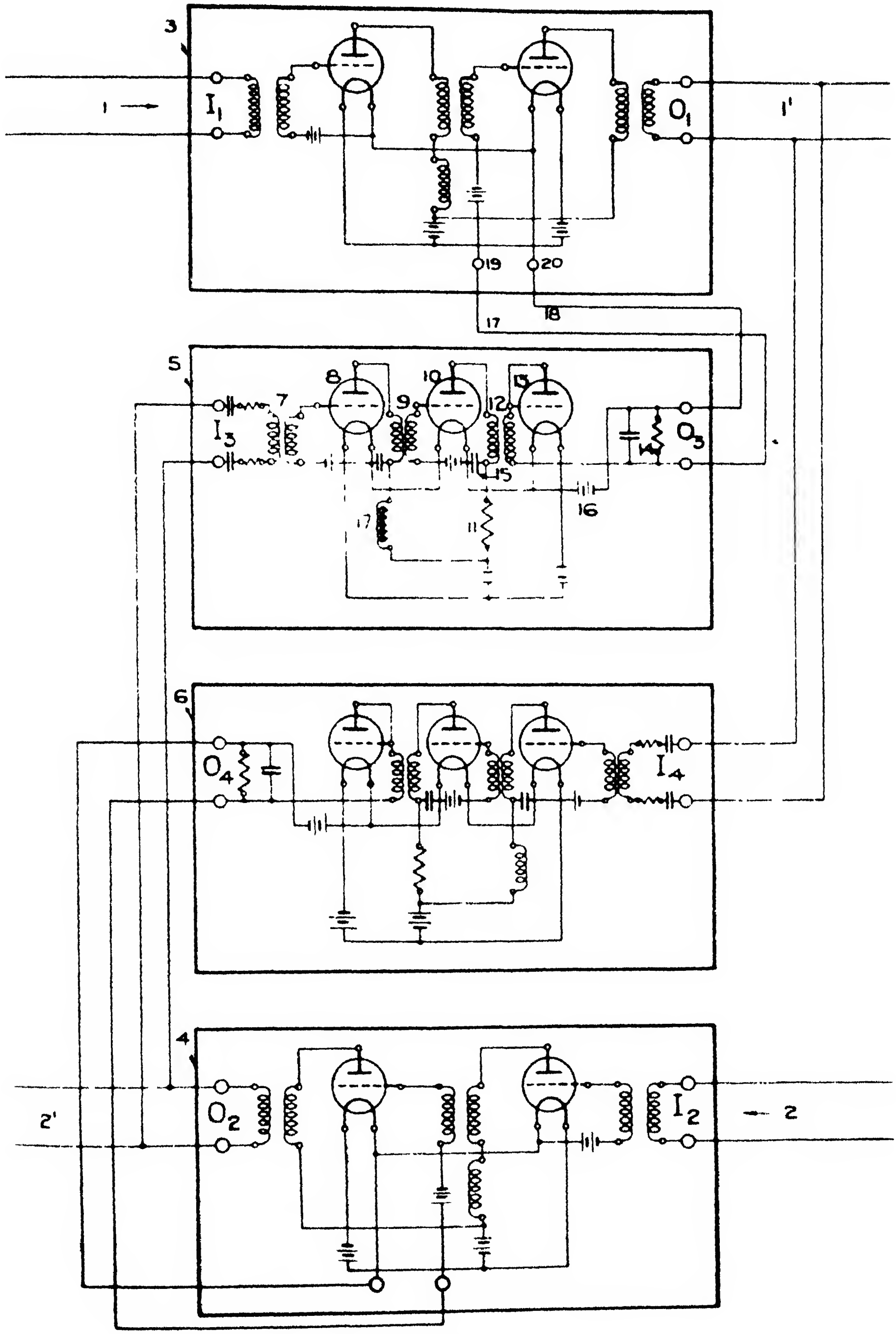

3
1
I_1
O_1
1'
19
20
17
18
5
7
8
9
10
12
13
I_3
O_3
14
15
16
17
11
6
O_4
I_4
4
O_2
I_2
2'
2

FIG. 4

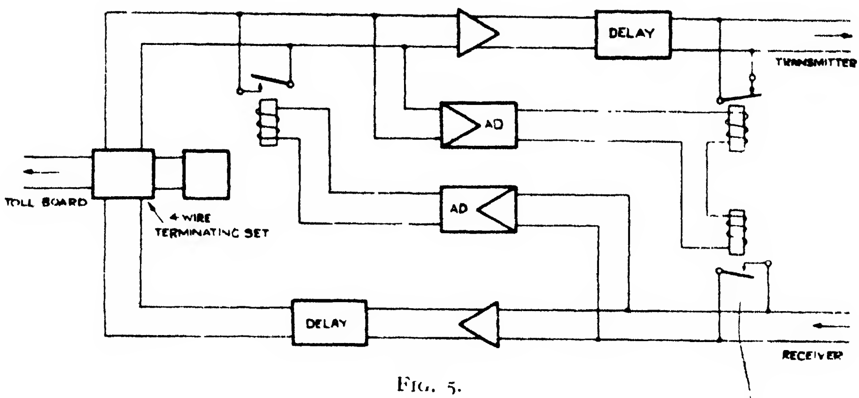


FIG. 5.

with the transatlantic circuit, which differs from a normal echo suppressor in that it is capable of suppressing an echo having a zero delay. This is made necessary because of the desirability of operating transmitting and receiving stations on the same wave lengths, so that the receiving system is capable of amplifying the relatively weak signals received from the distant station and yet rejects the much stronger signals received from the local transmitting station. For this purpose, to avoid clipping of the speech, it is necessary to introduce delay networks to retard the speech while switching operations are in progress. Referring to Fig. 5, the upper circuit carries outgoing speech to the radio transmitter and the lower speech circuit carries speech from the radio receiver to the subscriber. The receiving circuit is normally through and the transmitting circuit is normally blocked. Outgoing speech from the toll board arrives first of all at the amplifier detector bridged across the upper circuit and operates one relay which blocks the incoming circuit and another relay which removes the short circuit from the outgoing path. In this condition incoming speech or noise has no effect on the circuit.

On the cessation of outgoing speech the circuit returns to normal. Incoming speech blocks the outgoing circuit (close to the four-wire terminating set) and so prevents any unbalance currents passing the terminating set from operating the amplifier detector associated with the outgoing circuit.

In every case the delay network is of such a length that the switching processes are complete before the speech arrives at the output of the delay network.

(*d*) *Interference* in telephone circuits may be inductive or may be introduced by the charging and floating machines associated with the power plants of the amplifier stations ; in the case of radio links the question of atmospherics has also to be considered. Inductive interference is introduced either by neighbouring power circuits, by telegraph circuits on the same route, or by speech circuits on the same route, in which case it is referred to as crosstalk.

Power induction is guarded against by careful survey of the route before

laying the cable, by suitable transpositions in the power lines themselves, by bonding on electrified railways, and by selective interconnection of the conductors of the cable at joints to balance the conductor capacities to earth.

Interference from power plants is reduced to a minimum by separating power supply circuits from speech circuits and by the insertion of filters in the power supply leads.

Reduction of telegraph interference is effected by the use of noise killers which are sometimes referred to as shaping circuits and which consist of low pass filters to suppress the high frequency components of the telegraph wave which are most serious in causing interference.

Crosstalk is reduced to a minimum by careful adjustment of the speech levels, by balancing the internal capacities in each quad, and by special attention to the inductance and resistance balances of loading coils, as well as by taking care to keep the conductor resistance of the cable itself balanced. Special care has to be taken in the layout of repeater stations and design of repeating coils, as well as in the arrangement of supply circuits, both low tension and high tension, since these are always common to a large number of repeaters.

The question of atmospheric interference has been left to the last, since it is a very special problem in itself. During certain periods of the day and year the interference by atmospherics, coupled with fading in the signal strength, is sufficient to render the circuit entirely inoperative. In order to reduce this inoperative period to a minimum special precautions are taken in the choice of wave lengths, in the location of the transmitting and receiving stations, in the type of antennæ, in the type of modulation process, and in the operation of the circuit, to ensure that the maximum ratio of signal to noise is always obtained. Generally speaking, it is always possible at any one time to choose such a wave length that satisfactory communication can be established, and this with a total use of only two or three wave lengths. The removal of the receiving station in England from Wroughton, Somersetshire, to Cupar, Scotland, was brought about purely on account of the better reception, and for the same reason the receiving station in America was located at Houlton, Maine.

Directional antannæ are used both for transmission and reception, and are an important factor in increasing signal strength and reducing noise. The single side band system of transmission in use at Rugby, in conjunction with complete carrier elimination, enables the highest degree of selectivity to be used in the receiving system, combined with a maximum radiation of energy at the frequencies carrying the speech characteristics. In the operation of the circuit precautions are taken to ensure that the radio transmitter is always fully loaded irrespective of the strength of the speaker's voice, so that the maximum received field strength is always obtained.

The evolution of radio links has now reached such a stage that the terminals of such a connection can be regarded in exactly the same way as the terminals

of a land line connection, both from a technical and from an operating point of view. It is, of course, evident that, since radio links are usually costly, they should be operated on a similar basis to a high priced long distance circuit, with a maximum economy in line time. From a technical standpoint no point on the earth is so remote from another that it is impossible to connect the two by long distance telephone. Obvious economic limitations of supply and demand up to now have prevented the installation of many very long circuits. The circuit which was recently set up between Stockholm and New York is an example of the possibilities of long distance communication. This circuit was 22,264 kms. long, and was made up as follows :—

10,400	kms.	of extra light loaded cable
4,700	,,	radio link
6,850	,,	of open wire line
314	,,	of submarine cable

It was equipped with 138 four-wire repeaters, 24 carrier repeaters, 6 cord circuit repeaters and 8 echo suppressors, including the special voice operated switching device at London and New York.

I now propose to deal with the number of communications possible over the same pair of wires at the same time and in considering any available telephone circuit of a type consisting either of aerial lines or short cable lines there is available for transmission purposes a frequency range extending from zero or a few cycles per second up to 30,000 cycles per second. Various communication systems have been designed to enable the maximum use to be made of this frequency range.

These systems comprise :

(1) The Composite Telegraph System, which is superimposed on the telephone system and occupies the frequency range from 0-80 cycles.

(2) The Carrier Telegraph System, which occupies the frequency range from 3,000 to 10,000 cycles.

(3) The Carrier Telephone System, which occupies the frequency range from 5,000 to 30,000 cycles.

The telephone channel is limited to the frequency range, 100–3,000 cycles, to permit the simultaneous use of one or more of the other communication systems.

The Composite System on an open wire telephone circuit provides two independent earth return telegraph channels. The speed of transmission over each channel may be up to 25 cycles per second or approximately 60 words per minute Morse, and by the use of the ordinary telegraph duplex balance, the transmission may be in two directions simultaneously.

It will be evident that the use of telephone ringing current falling within the range 0 to 80 cycles will not be permissible over a composited circuit, since

it would interfere with the telegraph, and therefore it is necessary to insert special Composite Ringer apparatus, in the Exchange side of the line, repeating coils in all cases where the telephone signalling is by 16 cycle currents. The composite ringer translates the outgoing 16 cycle ringing current from the exchange to a higher frequency, usually 135 or 500 cycles, and transmits this over the line. Similarly it translates incoming calling signals from the line and transmits 16 cycle current to the exchange.

The Carrier Telegraph System provides 10 independent telegraph channels in both directions, each channel being capable of transmission at a telegraph speed of 40 cycles.

In carrier telegraphy the currents are more severely attenuated than in the case of direct current telegraphy, and carrier telegraph repeaters must be provided to compensate for the increased attenuation. These repeaters have been designed so that their spacing will correspond with the telephone repeater spacing on the line, and it is thus possible to accommodate the telegraph repeaters in buildings already housing telephone repeaters.

Carrier Telephone Systems provide one or three more channels over an open wire line or short underground or submarine cable which may be already in use for the usual purposes, *e.g.*, voice frequency telephony and composite telegraphy. From a trunk exchange operator's point of view there is no difference between a carrier circuit and any ordinary trunk circuit. The subscriber will notice only that the carrier circuit is free from the noise usually found on open wire trunk lines. The carrier equipment required can be classified roughly as carrier terminal equipment or carrier repeater equipment. At carrier terminals the speech frequencies received from a subscriber's set are used to modulate the carrier frequency. Modulation has the effect of converting the speech frequencies to higher frequencies, and it is these latter which are transmitted along the line. At the receiving terminal the high frequencies are "demodulated," or detected, and thus brought back to their true place in the frequency scale. By moving the frequencies resulting from several subscribers' lines to different parts of the frequency scale it is possible to provide several conversation channels on the same pair of wires. Separation between the frequencies resulting from the different conversations is effected by means of electric wave filters which are designed each to pass a band of frequencies and to eliminate all others.

Carrier repeaters are used on lines where the attenuation is too great to permit the use of terminals only. They have been designed so that their spacing corresponds with the usual spacing of voice frequency repeaters for the cause already mentioned.

Although it may be thought that carrier apparatus must be comparatively expensive, it is found in practice to be otherwise. In many cases, particularly for distances greater than 200 miles, it is cheaper to install and maintain carrier systems, than to provide and maintain additional pairs of wires to

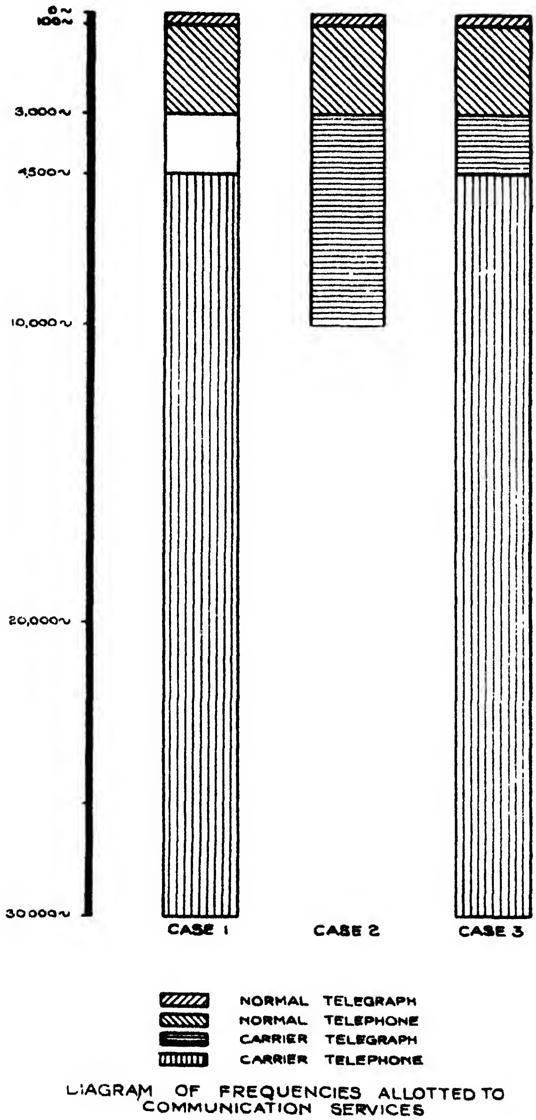
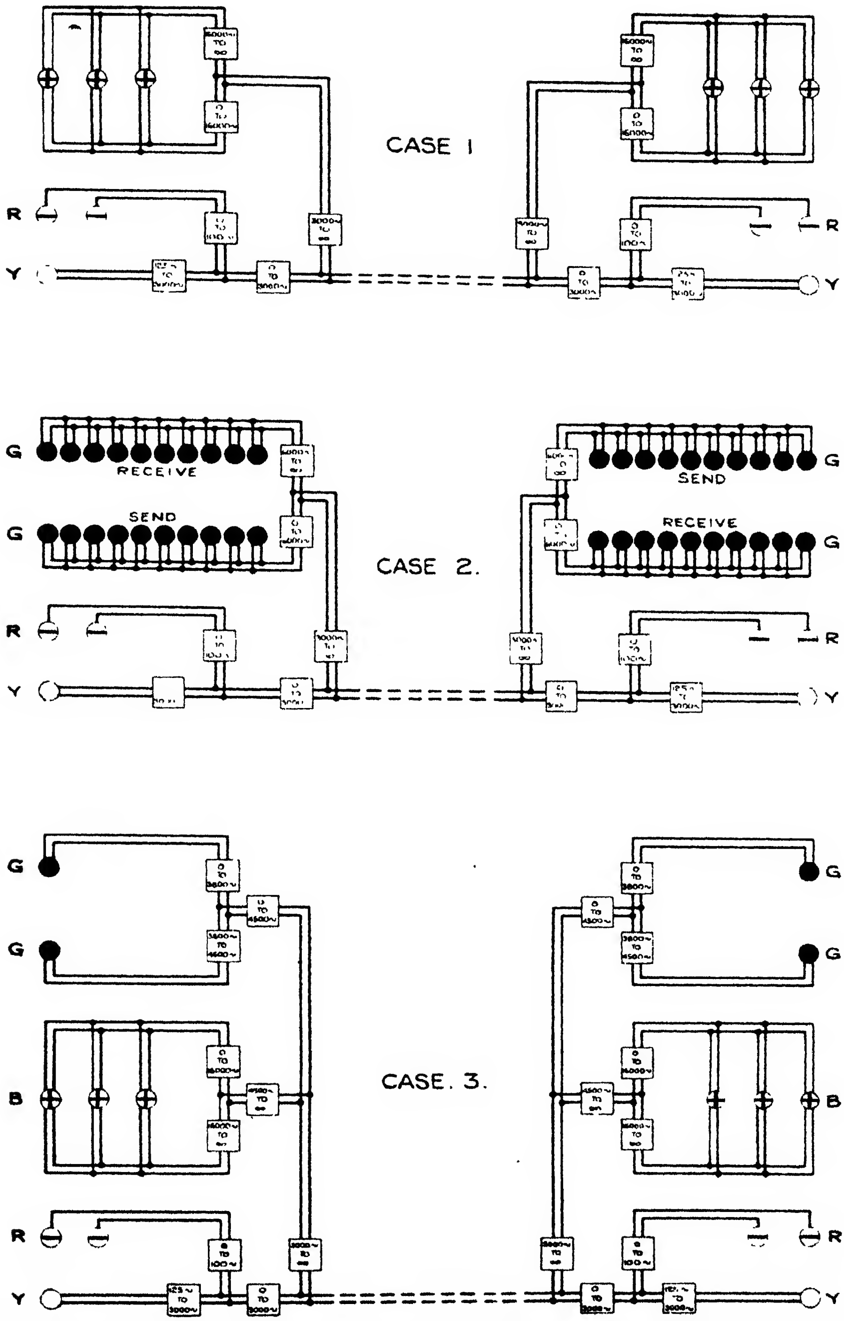


FIG. 6.

give the same facilities. Indeed, a single channel system has proved to be economical for distances as short as 40 or 50 miles.

The diagram Fig 6. indicates the frequency range occupied by the various systems, and Fig. 7 shows three alternative cases of their application to a telephone circuit.

In Case 1, Fig. 7, we have :—



⊖ NORMAL TELEGRAPH. Y ◯ NORMAL TELEPHONE. G ● CARRIER TELEGRAPH

B ⊕ CARRIER TELEPHONE. ☐ SEPARATING FILTER

FIG. 7.

One normal telephone circuit
Two composite telegraph circuits
Three carrier telephone circuits

or a total of 4 telephone and 2 telegraph circuits.

In Case 2, Fig. 7, we have :—

One normal telephone circuit
Two composite telegraph circuits
Ten carrier telegraph circuits

or a total of one telephone and 12 telegraph circuits.

In Case 3, Fig. 7, we have :—

One normal telephone circuit
Two composite telegraph circuits
Three carrier telephone circuits
Two carrier telegraph circuits.

or a total of 4 telephone circuits and 4 telegraph circuits; this, I believe, represents the greatest amount of traffic that has been commercially carried, although I am aware that much greater capacities have been described in published papers, but not necessarily as actual accomplished results.

All telegraph circuits can be worked duplex

In the first of these two cases the services can be operated at the same time without much difficulty, but in the third case careful consideration is necessary to ensure the location of the carrier telegraph channels in a range where they will not interfere or be interfered with by the carrier telephone channels, and it is probable that they will be restricted to the range 3,000 to 5,000 cycles or the range above 30,000 cycles. There is set up in this hall two terminal equipments connected by a pair of wires and equipped with ordinary telephone sets, two composite telegraph channels, one carrier telephone channel and one carrier telegraph channel, and by operating them all separately and then simultaneously but only receiving one at a time, their simultaneous operation without interference can be demonstrated.

DEMONSTRATION.

At the conclusion of the lecture the following experiments were carried out with the demonstration equipment :—

Conversation took place, or the telegraph apparatus was operated, on each channel of communication separately with all other channels silent. The loud speaker was connected in each case first to the mid point of the line, and then, in the case of the telephone circuits, to one of the terminals; in the case of the telegraph circuits the operation at the terminal was observed, not on the loud speaker, but on the telegraph apparatus.

From these experiments could be judged the effect of the set of frequencies used for each channel as transmitted on the line.

The next stage was to have all channels operated simultaneously, the jumble of frequencies passing along the line being observed by connecting the loud speaker to the line.

To indicate that each of the channels was successfully separated from the others at the terminal equipment the final stage was to add the channels one by one to the line, to observe the effects on the line as each was added, by connecting the loud speaker to the line and then, by connecting the loud speaker to the terminal apparatus, to notice that each channel was functioning satisfactorily, as though the other channels were not in existence.

DISCUSSION

THE CHAIRMAN, in opening the discussion, said the audience would wish to join in his appreciation of the extraordinarily interesting way in which Mr. Nash had described what was, he supposed, the most extraordinary thing which man had yet done on this planet He doubted whether anybody had come across anything in which man had gone more completely beyond what would have been expected That our tiny voice "that poor little noise we make every time we speak" should be capable of going 18,000 miles was extraordinary, and the fact that a single wire should be able to carry so many different messages at the same time was wonderful.

The thought which had kept coming into his mind as he had listened to the lecture had been how like it all was to what happened in our own brain. Neurologists said that the ordinary human brain had about as many separate living cells—neurons—as this world had inhabitants That was to say, each of our brains had got about 1,400 million "inhabitants," and each of those "inhabitants" was on one telephone system namely, the nerves. Many of those "inhabitants" had as many as ten different wires (nerves) leading to them Therefore, each of us owned a very complicated telephone system, equivalent to the whole world on one telephone system. Mr. Nash and his friends and contemporaries were coming very near to that same sort of organism He supposed it would not be very long before every inhabitant of this globe was on the telephone, and the interesting thing then was to think that the globe as a whole would behave as one individual. The next problem would be for that individual to find some other "individual" to talk to; otherwise life would be very dull!

There were many things he would like to say, but he would confine himself to expressing his personal appreciation for the immense amount of trouble to which Mr. Nash had gone in giving his demonstration

MR. A. DAVIDSON (Vice-President, All-America Cables, Inc.), said that personally he had been interested all his life in submarine cables. Possibly, in the advance of research in connection with submarine cables, a great deal of the work which had been done on lines and circuits would find a place in the submarine cable. It seemed to him that communications of all kinds were coming closer and closer together. Nowadays we did not know where one began and where the other ended. He expressed his very hearty appreciation of the paper.

DR. F. J. W. WHIPPLE (Assistant Director, Meteorological Office), said he could find nothing but praise to give to such a delightful lecture as Mr. Nash had delivered.

Mr. Nash had a manner of delivery which had a very special charm in it, and he had kept the audience intensely interested the whole evening. For him to say anything more would be presumption, and therefore he would sit down again expressing his appreciation.

MR. LLEWELYN B. ATKINSON said he had been delighted with the lecture and had learned a great deal from it. He was not a telephone expert in any sense, but he had been carried that night a very long way mentally on the subject. When he had been born the Atlantic telegraph was in existence; the world had got as far as that. It had been a very slow business and highly expensive. He recollected the invention of the telephone. He had seen what had been probably one of the first half-dozen sets made in this country. He had tried it as a boy in the house of an old friend—the father of one of his school companions, who had made it himself. He had been present at the first trials. He had seen the development of telephone exchanges from very small and rudimentary affairs up to what they were now, including the various automatic systems. He had seen the development of wireless telegraphy before wireless telephony was thought of at all, when it had been purely the transmission of Morse signals at first over comparatively small, and then longer, distances. He had been living in South Wales at the time that Marconi had first come to England and succeeded in interesting Sir William Preece to trying his system. He had found an old letter which he had written to his father in the following terms:—"Preece had invited me to dine with him to-morrow night to meet a chap named Marconi, who claims to be able to send messages without wires." A few days after that Marconi had succeeded in demonstrating to Sir William Preece and to the British Post Office that he could send such messages. He had seen these things come about one at a time, so the audience could imagine that, as an electrical man, he had followed them all with the very deepest interest. Of later years developments had gone at such a pace that unless one was specialising, as the lecturer was, one soon got out of one's depth. That was why he valued the lecture, which, although it involved some technicalities, had been given in such an easy and clear style that most present, even those who possessed no technical knowledge, had understood the points and difficulties connected with the subject. The subject of broadcasting had not been dealt with, except in general terms, which reminded him of the proposition that the three ways of most rapidly distributing information were telegraph, telephone and tell-a-woman. The last was the broadcasting system.

MR. E. S. BYNG (Standard Telephones & Cables Limited), amplified in a few technical details the lecturer's diagram of the connection between the long distance exchanges and explained that this intermediate link, consisting of toll cable, loading coils and repeaters, represented a very important development which had taken place during the past ten years. The progress thus achieved had now made possible, technically and commercially, an "all-cable" telephone communication between practically all European countries, and although the radio links, as described by the lecturer, might play an important part in the connection of distant continents, there would, in his opinion, always be a need for a high grade type of cable and its accessories, which would continue to call for still further improvement and development.

A hearty vote of thanks to the lecturer concluded the meeting.

NOTES ON BOOKS.

SOME NOTES ON BOOKBINDING. By Douglas Cockerell. Oxford University Press. London. Humphrey Milford. 5s.

A concise, scholarly and useful little book, by a man whom we must regard as one of those chiefly responsible for the high standard maintained by a group of contemporary craftsmen.

The author does not exaggerate the material prospects that lie ahead of a novice in book binding. This is not a lucrative craft; but one wonders whether the caprice of fashion might not bring into existence a new society of amateurs, who would spend at least so much per year on finely printed and bound books. Such a turn of affairs is not unthinkable.

The latest show of bindings at the L.C.C. Central School of Arts and Crafts is the best witness to the value of the lectures given to the students by Mr. Cockerell, and here published with slight modifications. The specialist will appreciate the analysis of what constitutes efficiency in the various stages of production, and everybody will be interested in the author's general comments on the finished article.

The note reprinted at the end of the book is especially useful to owners of precious books and to librarians, as it deals with specifications and "how to give orders for binding."

BUILDING CRAFTSMANSHIP IN BRICK AND TILE AND IN STONE SLATES. By Nathaniel Lloyd. Cambridge University Press. 15s. net.

The charm of a house or cottage depends not only on the main design but also on refinements of detail in the execution of the work. Small awkwardnesses are able, out of all proportion, to spoil the whole of which they are a part; see, for instance, Fig. 158 in Mr. Lloyd's book, from which it is obvious that excellent contours have to be supported in the right way by the right materials if they are not to be a failure.

In building, texture is both the surface generally and the inter-relation of the units of the surface: it is therefore actually one element in the design and so a more important factor even than in painting. In the case of old cottages, which are by nature more charming than intellectual, texture and craftsmanship, the choice and application of brick and tile, are nearly everything. The layman may be surprised to find how much sophistication the harmonious treatment of these materials presupposes.

As Mr. Lloyd says in his preface, whether one is restoring or adding on to an old cottage, or building a new one, it costs no more to get those details right on which so much depends, than to get them wrong. I should like to see his book, in a cheap edition if possible, in the hands of all the country builders in England; some of whom, animated by the highest motives, occasionally spoil the ship for a ha'porth of tar which they do not really grudge. Those not animated by the highest motives might, on reading *Building Craftsmanship*, see the error of their ways and repent.

Mr. Lloyd's examples are divided between the anonymous work of old builders, whose unerring instinct for what was at the same time practical and beautiful is so often impressive, and the designs of eminent architects. Since Inigo Jones, England has nearly always been blessed with architects of great talent, in whom the scholar and connoisseur has by no means ousted the creative artist. Just as nothing reflects more credit on Ictinus than the section of his cornice mouldings, so nothing could illustrate more agreeably the versatile genius of Sir Edwin Lutyens

than details of his brick and tile combinations, as shown in this book. See Figs 118 and 123. Admirable, also, is the finial with its gauged brick ball by E. Detmar Blow, Fig. 104.

Mr. Lloyd approves of fancy tiles for weather tiling, at any rate alternately with plain tiles, but there seems no doubt that only time can make them lose their air of affectation ; they are apt not to be good in themselves.

An excellent book, happily appearing at a moment when one hopes that the movement for preserving old cottages has stimulated widespread interest in the subject with which it deals.

Alkaline Accumulators. By J. T. Crenell, B.A., and F. M. Lea, M.Sc., A.I.C. London : Longmans, Green & Co., Ltd. 10s. 6d. net.

The alkaline accumulator, a product of the present century, has not yet won its way to popular favour ; indeed, it is probable that only a very small percentage of the users of accumulators have so much as heard of the existence of the alkaline variety. Nor is this because the ordinary or acid type is in any sense a satisfactory article. On the contrary, as everyone knows, it requires constant skilled attention if a reasonable standard of performance is to be obtained ; and even under the most favourable conditions its life is short but far from gay.

The newer type of accumulator now under consideration, while it has its own faults, possesses sufficient advantages to deserve a special text-book. The authors have presented the subject in a commendably impartial manner, but they have succeeded in making it evident that such further progress as may reasonably be expected will probably place the alkaline accumulator in a very favourable position in relation to its acid competitor.

The terms acid and alkaline in the present connexion refer to the electrolyte solutions, sulphuric acid and caustic soda respectively, which are used in the cells ; but of course the electrodes also are widely different. As is well known, the acid accumulator has a positive lead plate covered with lead peroxide, and a negative lead plate covered with spongy lead ; but in the new type the positive material is mainly a mixture of nickel oxides held in contact with a nickel plated steel plate, while the negative pole is roughly similar in construction, but holds a mixture of iron oxides, to which cadmium is sometimes added.

Feeling that little real comprehension of the subject could result without a grasp of the underlying theory, the authors have given a brief general account of electrode and electrolyte action. From the point of view of pure physical chemistry, this has been most admirably done, many customary fallacies having been carefully avoided. These theoretical sections constitute, in fact, a remarkable piece of accurate and sound summarization, and could be read with great advantage by many who are not specially interested in accumulators ; one's only doubt is whether they will not be found too condensed by those who are not already familiar with these electro-chemical problems.

The main part of the book, however, is concerned with more practical matters; the manufacture, characteristics and treatment of alkaline accumulators are fully described, and their behaviour is compared with that of the acid type. The alkaline cells have a lower efficiency from the purely electrical point of view, their voltage during discharge is less constant, they are more bulky and more costly, and their state of charge at any instant is less easily ascertainable ; on the other hand, they have a longer life, their maintenance is much simpler and cheaper, they retain their capacity at much higher rates of discharge, and finally the alkaline electrolyte with its absence of fumes, is in many circumstances a decidedly advantageous feature.

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FRIDAY, AUGUST 2nd, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

PROCEEDINGS OF THE SOCIETY.

TWENTY SECOND ORDINARY MEETING.

WEDNESDAY, 15TH MAY, 1929.

JAMES SWINBURNE, ESQ., F.R.S., Past President of the Institution of Electrical Engineers, in the Chair.

The following paper was read: –

THE REFORM OF THE BRITISH PATENT SYSTEM.

By ROBERT BURRELL, Barrister-at-Law.

The subject upon which I have the honour to address you this evening, namely, the reform of the British Patent System, is a very extensive and important one, and it is obvious that in the space of one hour it would be useless to attempt to deal exhaustively with the subject. I understand that this Society may arrange further meetings at which it will be possible to go into some of the questions raised in more detail. In these circumstances it seems to me that the most useful contribution that I can make towards the discussion of the problem this evening, is to review in more or less a general manner the various difficulties of our present system as a whole, even if I am unable, to deal exhaustively with any particular case.

My task is considerably simplified by the work recently undertaken by the British Science Guild, which in April, 1927, appointed a very distinguished committee to consider the question. This Committee has recently issued its report, and this report contains a number of important recommendations covering most aspects of the question.

I think it will be convenient, therefore, in discussing the subject, that I should follow, as far as possible, the same order of treatment as has been adopted in the Report to which I refer. Before dealing in detail with the Report, however, I desire first of all to make a few general observations with regard to some of the points of view from which, in my opinion, the question of the reform of the British Patent System should be approached.

International Considerations

The British Patent Law owes its origin to, and is still based upon, the "Statute of Monopolies," which was passed in the reign of James I. At that date industrial conditions in this country differed vastly from the conditions obtaining at the present time. The introduction of improved communications alone has completely altered the character of industry as we know it, from industry as it existed in the time when the Statute of Monopolies was passed In the days of James I industry was, comparatively speaking, a local matter whereas to-day the whole world are the potential customers of the successful industrialist. In considering the reform of the British patent system, therefore it is important that the question should be regarded not merely from an insular point of view.

It may at first sight seem unnecessary when considering the reform of the British patent system to have regard at the same time to the patent laws in force in foreign countries. As a matter of fact, this is not so, and it is of the utmost importance not only carefully to consider the various systems in force in other countries, but also the terms of any international convention dealing with the subject of industrial property.

The value of a British Patent to a British manufacturer lies not so much in the monopoly which he thereby obtains in this country, as in the international monopoly obtainable on the basis of the application made in his country of origin. The extension of protection to foreign countries is regulated by the terms of the International Convention of Paris of 1883 as amended at the Hague in 1925. Great care must, therefore, be taken to ensure that no amendment of our existing system is introduced which will in any way imperil the very valuable privileges which may be secured if the terms of the Convention are duly observed.

The International Convention in its present form in no sense imposes on any Convention country any definite code of law, and is mainly concerned with the unification of the formalities necessary to obtain protection and with the establishment of a uniform period of priority.

This period of priority is of 12 months duration. Any applicant for a patent or equivalent protection in any of the Convention countries is, therefore, entitled at any time within twelve months of the date of application in his country of origin to apply in the Convention countries for protection, with priority dating back to the date of original application in his home country.

It should be observed that priority does not extend back further than the date of original application. If, therefore, any amendment of English law were introduced whereby the effect of a publication in this country prior to the date of application were modified, such amendment would, so far as the International Convention is concerned, be of no effect. I may, perhaps, illustrate what I have in mind by reference to the practice of the United States of America. Under the United States law it is not necessary that an inventor should lodge his application for protection before publishing his invention to the world, and under American law, two years are allowed after publication within which to apply for protection.

In many foreign countries, however, an invention, in order to be capable of protection, must be one which at the date when the application is made has not been previously published in any part of the world. As a result, many an American inventor who obtains valid protection for his invention in the United States finds, when he applies abroad, that he is unable to obtain protection owing to a publication made by himself in the United States prior to his application for protection in that country. This example illustrates the importance of paying due regard to the existing laws of foreign countries, and in particular to the terms of international industrial property Conventions, when considering the desirability of the introduction of any particular amendment into the British patent law.

There are, however, other reasons. We are an insular people, and are somewhat disinclined to trouble ourselves about the legal systems in force in other countries. In the last few years it has been my privilege to participate in a number of international conferences at which patent questions have been discussed, and I have been much struck with the close attention with which the development of the British patent and trade mark systems are watched by experts in other countries. In advocating any particular change in the English legal patent system, we must, therefore, remember that any such change will at once be carefully noted by those concerned in industrial property questions in foreign countries, and there is always the possibility that a change in the British law may be followed by a similar change in foreign law. This applies, of course, with particular force to the Dominions and the British Colonies and Dependencies.

I can well conceive circumstances in which a particular amendment of the English law might be suited to British industrialists, whereas the introduction of similar legislation in the patent systems of foreign countries, or in the Dominions and British Colonies, might be very detrimental to British interests. Indeed, the disadvantages might well outweigh the advantages to be gained by the introduction of the change into the British system.

The difficulty which British manufacturers encounter in obtaining adequate protection for their inventions in foreign countries is largely due to the fact that, although inventions are of international application and utility, the

protection in the various countries abroad must be obtained in virtue of the local laws, which laws are unfortunately lacking sadly in uniformity.

The International Convention of Paris is practically the sole instrument available for securing a larger degree of uniformity of law than has hitherto prevailed.

At the periodical International Conferences at which the text of the Convention is revised, the British Government has always insisted upon the desirability of international uniformity, and has done much to remove many of the irritating anomalies which have hitherto proved such a thorn in the flesh of British manufacturers There have, however, also been complaints as to some details of the British practice, which, in some instances, is peculiar to this country I refer, as an example, to the British practice of ante-dating a Convention application to the date of original application in the country of origin. In considering whether our British practice in this respect should be amended, even though we may be of opinion that the system of ante-dating is the correct and logical system, we ought, I think, carefully to weigh as against the disadvantages of introducing any change, the advantages likely to be gained by the adoption of a system which has uniformly been adopted by all the other countries of the Union except Great Britain and her colonies. If this country makes some sacrifices in the interests of international uniformity, she will be in a much stronger position to bring pressure on other countries to come into line on other questions perhaps of even greater importance, upon which at present there is no uniformity of practice. As an instance, I may perhaps refer to the question of third party rights.

The International Convention is next due to be revised at the London Conference of 1933. The duty of preparing the ground for the revision of the Convention at this Conference is, according to the terms of the Convention itself, entrusted to the Director of the International Office at Berne in collaboration with the Government of the country in which the conference takes place The preparatory work in connection with the London Conference will therefore largely fall upon the British Government. It is, I think, important to mention this, because the acceptance by the British Government within the next three years of any of the principles underlying the recommendations made in the report of the British Science Guild would naturally bind the hands of the British Government in the preparation of the work for the International Conference.

Science Guild Report.

Now I turn to the Report itself. In the Report the various questions are dealt with under seven headings, namely, Conditions of Validity, Short Term Patents, Applications for Patents, Proceedings before the Comptroller, Proceedings in the Courts, Availability to the Public of Information in the Possession of the Patent Office, and Financial Considerations. I propose

largely to follow this order of treatment, although owing to lack of time, I shall not be able to deal individually with all the recommendations made by the Committee. Although time is short, I am anxious also, if possible, to refer, although quite briefly, to one or two other matters not dealt with in the Report, but which, in my opinion, might usefully be discussed in connection with the Reform of the British Patent System.

The recommendations in the Report, taken as a whole, may be said to be directed to four defects in our present system, and the various reforms proposed aim at ensuring:—

(*a*) A greater degree of security, both to inventors and the public, against the grant of invalid patents

(*b*) The extension of the protection of the patent laws to inventions which are at present unpatentable, either because they are not "manufactures" within the meaning of the Statute of Monopolies, or because they are devoid of patentable subject matter, in the sense that they lack inventive ingenuity.

(*c*) A reduction in the cost of patent litigation.

(*d*) The reduction of the existing congestion at the Patent Office and the introduction of facilities ensuring a quicker patent grant than is at present possible.

Novelty.

Under the first of the above heads a number of far-reaching proposals are put forward by the British Science Guild. Important changes of law are suggested with regard to the official investigation as to novelty, the effect of prior publication by the patentee himself, anticipation of a patent of addition by the parent specification, the endorsement of doubtful specifications with warning notices as to the sufficiency of description, and the enumeration in the Act itself of the conditions of validity.

In order that a patent may be valid the invention claimed must, of course, be new. This condition, which is to be found in the Statute of Monopolies, is a condition which, so far as I am aware, is also to be found in the patent law of every other country Under existing British practice prior to the grant of a patent, the application is subjected to a more or less strict examination by the British Patent Office, though this examination is of very limited extent, and does not extend to all the prior documents which may come under consideration, if the validity of the patent is challenged in the Courts on the ground of absence of novelty.

It is obvious that such an examination cannot give any guarantee as to the novelty of the invention claimed, and it has also other disadvantages. In the first place it weakens very considerably the value of British patents as compared with foreign patents which have been subjected to a more extensive system of search; secondly, it does not enable an inventor who is anxious to

obtain a cast-iron patent to obtain such information as is available in the Patent Office as to the state of the prior art; and, thirdly, it results in the grant of invalid patents, which until they have been challenged and proved to be invalid, may considerably hamper the legitimate activities of British manufacturers.

In this connection it must, of course, be remembered that the official search, though essentially directed to the question of novelty, also facilitates the drafting of a specification, in such a way as to disclose patentable subject matter.

In the Report it is first of all suggested that a patent should not be invalidated by the publication of any document more than 50 years before the date of the patent If the search is to be restricted to the same period this suggestion seems to me to be based on sound common sense. It is admitted that its result might possibly be to confer validity on a few patents which would otherwise be invalid, but this disadvantage would be very slight as compared with the advantages which would follow. The chief advantage of the suggestion is, of course, that it would obviate the need for searching amongst very old literature in investigating the validity of the patent. I do not suppose that the suggestion will meet with much opposition. It is, in fact, already embodied in the Australian Patent Act.

Official Search.

The most important recommendation which is made in connection with the question of novelty is, however, the proposed extension of the official search to all such documents as would be citable against novelty as a defence in infringement proceedings. From the logical point of view I do not think that the proposals made by the British Science Guild can be questioned. Obviously the official investigation as to novelty should be coterminous with the investigations in infringement proceedings, or there should be no search at all. Under the French system, patent applications are not subjected to any kind of search as to novelty prior to grant, the whole question of novelty being left to the French courts This is also a perfectly logical system.

The French system, however, is not one which is likely to appeal to British manufacturers Indeed, even in France itself, there appears to have been a movement in favour of the introduction of a preliminary search. In France, however, the proposal was to establish two kinds of patents, patents granted without preliminary search, i.e., Deposit Patents, and patents granted after search, it being left to the free choice of the applicant to demand which kind of patent he preferred. Patents granted after search would be marked with a clear indication to that effect, in order to distinguish them from Deposit Patents.

A proposal on these lines was contained in the Patent Bill of Mr. Reynoldi, the French Minister of Industry and Commerce, which was recently submitted to the Chamber of Deputies. The idea underlying the proposal was that in

some cases it was of the utmost importance that a patent should be granted with the least possible delay, whereas in other cases delay was not a matter of much consequence provided that a patent could be obtained possessing some presumption of validity. Whether any such system would be acceptable in this country I very much doubt, and I accordingly only mention the matter from the point of view of interest.

I do not propose to deal here with the suggestions made by the British Science Guild as to the method which should be adopted in introducing the extended search, namely, in successive stages or instalments. Nor do I intend to refer in detail to the financial considerations involved by the proposal. It may be that the expense which would be involved by the introduction of an extended search would meet with considerable resistance from the Treasury, particularly if the present rate of renewal fees were to remain in force.

As to the desirability of the extension of the present search I have little doubt, and its practicability is merely a question of finance. If an extension of the search could only be secured at the cost of a substantial increase in rate of patent fees, the financial disadvantage might well outweigh the practical advantages which an extension of the search might give.

Unless the present examining staff of the Patent Office were considerably augmented, an extension of the present search would inevitably result in a lowering of the present standard of search, and an increase of the unfortunate delay which already exists at the Patent Office in dealing with patent applications.

The proposed extension, therefore, ultimately depends upon the assistance of the Treasury. By that, I do not mean that the Treasury should contribute towards the cost of the search, but that the Treasury should cease to appropriate for other purposes monies which have been paid by Patentees as their contribution towards the cost of maintaining an efficient patent service.

For myself, I have often wondered whether it would not be possible, to institute a central international office for search purposes, such office, of course, having no administrative function other than that of pure investigation, the result of such investigation being accepted by the Patent Offices of each country in lieu of a national search, and the effect of any citations being determined by the laws of each country. Very large sums of money are expended each year in the investigations carried out in the various national Patent Offices, and any duplication of the work, which must necessarily occur under the present system, is really a waste of money, and the loss, of course, ultimately falls on patentees and the public. In 1916 an International Arrangement for the establishment of a Central Office for Search was in fact signed at Paris, by nineteen Governments, including the Governments of Belgium, France, Poland, Roumania and Czechoslovakia, but the agreement was never ratified and proved quite abortive. Anyone interested may consult the text of the Arrangement in Volume 286, of the Official Gazette of the United States Patent Office at

page 646. The idea underlying the Arrangement is, in my opinion, an important one, though I recognise that there are immense practical difficulties. The establishment of a Central Office would, however, be of very great value to those engaged in industry, particularly if the information contained in such Central Office were available to the public on the lines of the recommendations contained in Section F of the Report of the British Science Guild. I may add, as a matter of interest, that the establishment of a Central Search Office was definitely advocated by the American Group of the International Chamber of Commerce at the Brussels Congress of the Chamber in 1925.

True and First Inventor.

Whilst I am dealing with the question of novelty, there is one aspect of the question which does not appear to have been dealt with by the British Science Guild, but to which I may, perhaps, be permitted very briefly to refer.

In this country an invention will be held by the Courts to be novel if it has not been previously published within the realm, and any person who imports an invention into the country, whether he be in fact the actual inventor or not, is entitled as of right to obtain a patent in respect of such invention, such importer in law being "the true and first inventor." In this respect our law differs from the laws of most other countries, under which prior publication of an invention in any country will be held to invalidate the patent. At the time when the Statute of Monopolies was passed, travelling was still a somewhat dangerous occupation, and it was accordingly held that any person who imported a new invention into the country had rendered sufficient public service to merit the grant to him of a patent in respect of that invention. It is owing to the persistence of this theory that publications outside the realm do not affect the validity of a British Patent. Cases in which importation patents are obtained by a person who does not derive his title in some way from the true inventor are, however, comparatively rare, owing to the provisions contained in the International Convention which enable foreigners to obtain priority in this country for inventions originally applied for in a foreign country. If, however, to take an illustration, a German professor were, in the course of delivering a lecture before a learned Society in Germany, inadvertently to disclose an invention before applying for a patent in that country, it would be perfectly open to anyone to whom the invention had been disclosed to take the next train to London and obtain a valid patent for the invention in this country in his own name. Whether it is desirable to retain in our law a principle which enables such a borrowing of an invention belonging to another person is a matter which I think might well be further considered.

Premature Publication.

The second proposal put forward by the British Science Guild under the head of Novelty is that publication made by or derived from an inventor

should in no case be pleadable against a patent subsequently granted to that inventor, provided that the patent was applied for within twelve months after such publication.

This proposal is, according to the Report, introduced to meet the hardships which sometimes occur in cases where an inventor inadvertently, or owing to ignorance of patent law, or through failure to realise the commercial importance of his invention, discloses his invention to the public before applying for a patent.

I am inclined to agree that the existing law may, in some cases, result in hardship. I am convinced, however, that owing to the international complications likely to result from the acceptance of the proposal, the matter is one which should be dealt with first of all under the International Convention.

The first difficulty which occurs to me is that the proposal would not, in any event, assist the inventor in obtaining protection in foreign countries. In many countries of the world, as I indicated earlier in my paper, a patent will be held to be invalid if the invention has been published in any part of the world prior to the date of application. Let us assume, therefore, that an inventor discloses in the United Kingdom an invention before a learned society on January 1st of this year, and applies for a patent on September 1st. Such prior publication would, according to the recommendations of the British Science Guild, not be pleadable against any patent obtained in this country as the result of that application. If, now, the inventor were to seek to obtain protection abroad, he would be able to apply for foreign protection at any time within twelve months of the date of his British application. But his period of priority would only date back to September 1st, the date of the British application. In those countries, therefore, in which prior publication in any part of the world is sufficient to invalidate the patent, the inventor would find that any patent obtained by him in such country would be invalidated by the publication made by him in Great Britain on January 1st. But there are also other difficulties.

One effect of the acceptance of the proposal would doubtless be to make inventors careless as to the publication of their inventions, forgetful of the fact that the amendment of the law proposed is a purely negative one, in the sense that no rights of priority are obtained by reason of any premature publication. Let us assume, as in the illustration already given, that A, a British inventor, discloses his invention before a learned society on January 1st of this year. B, a rival inventor, who is engaged on the same problem, independently makes the same discovery on June 1st and immediately applies for a patent, and soon afterwards publishes the invention. A then applies for a patent on September 1st. What is then the position ? B obviously cannot obtain a valid patent because of the prior publication by A. But what is A's position ? Although his own prior publication on January 1st is not pleadable against him, the publication by B is certainly pleadable, with the

result that any patent obtained by A will also be invalid. There are other difficulties besetting the recommendation of the British Science Guild in this connection, but the two illustrations which I have already given will, I think, be sufficient to emphasise the necessity of a very careful examination of the proposal before it is accepted. In any event, I am clear that the problem dealt with is a matter primarily for international regulation.

Secret User.

In dealing with the question of novelty the British Science Guild also refer to the effect of prior secret user by a patentee, but they make no recommendation. I observe, however, that in Paragraph 11 of the Report in which this matter is referred to, the view is expressed that under English law a patent is invalid if it can be proved that the patentee had used the invention for profit before applying for his patent, even if no publication has taken place. I am aware that there are certain text book writers who have expressed a similar view, but there is no judicial decision which definitely establishes that proposition, and a number of weighty arguments might be adduced to the contrary. Having regard to the uncertain state of the law both with regard to prior secret user by the patentee himself, and to the effect of a prior secret user by a third person on the validity of a patent granted to another, it would in my opinion be useful if, in any revision of the English law on the subject of patents, both these questions were finally settled. There is a good deal to be said in favour of the proposition that prior secret user by the patentee himself ought not to invalidate any patent for which he might subsequently apply. Indeed, so far as the public is concerned, the consideration which it receives when a patent is subsequently applied for, namely information with regard to the invention, is the same whether any prior secret user has taken place or not. The same argument applies in a case where an independent inventor discloses to the public an invention which has in fact been secretly used by a third person. Whether in the latter case a patent should be granted to the person who first discloses the invention is doubtful unless some provision be made to protect the prior secret user. Such protection might, if necessary, be given by the insertion in the Act of provisions on the lines of Rules 62 and 63 of the Patent Rules which apply to the case of lapsed patents restored to the Register.

I might add that owing to the uncertain state of the law with regard to the effect of prior secret user by a patentee, it would appear desirable to add a proviso to the recommendation made by the British Science Guild as to the effect of publication made by or derived from an inventor who subsequently applies within 12 months of such publication for a patent. I doubt very much whether it was intended by the Committee that a person who had previously used an invention in secret should be entitled, at any time within 12 months after the secret had leaked out, to obtain a valid patent for his invention.

Patents of Addition.

The Report also contains an important recommendation with regard to patents of addition. It is suggested that a parent specification should not be citable against a patent of addition as evidence either on the issue of novelty or subject matter. This recommendation is made with a view to encouraging an inventor to disclose improvements which experience has shown to be desirable in the working of his invention. It is important to remember, however, that one effect of the recommendation would be to enable a patentee at any time during the existence of the principal patent to obtain a patent of addition for any matters disclosed in the principal patent, but which he had omitted to include in the claims. This is a somewhat dangerous proposition, as it would result in permitting a patentee at any time during the existence of his patent, to extend the scope of his original claims It has always been a principle of British Patent Law that what is not claimed is disclaimed and, in my view, that principle is sound and ought not to be departed from.

Furthermore, cases might easily occur in which the unclaimed matter in fact constituted a separate invention. If, in such a case, the Patent Office were to accept a claim for such matter by way of a patent of addition, the public would be helpless. No objection could be raised in opposition proceedings on this ground under Section 11 of the Act, and under Section 19 (4) of the Act of 1907, the grant of a patent of addition is conclusive evidence that the invention is proper subject of a patent of addition. The difficulty referred to could, of course, be met by a suitable amendment of Section 11.

With regard to the question of subject matter, the desirability of the recommendation made by the Committee depends upon the same considerations as are applicable in case of short term patents, and as I shall be dealing with these as a separate matter, I need not deal with the question at this juncture

Sufficiency

In order that a patent may be upheld under the English law, the invention must be sufficiently described to enable a skilled worker to carry it out, and the invention must furthermore be useful, that is to say, the patented machine or process must actually function in the form in which it is described At the present time the Comptroller's powers in dealing with a specification which, in his opinion, is insufficient, are limited to one of two alternatives, either he must refuse the patent or he must grant it, and the British Science Guild suggests that there should be some intermediate course open to the Comptroller, and that when in doubt, he should be entitled to call for prima facie evidence that the invention has been described in a practical form in the specification, and that if his objection is not satisfied he should be entitled to endorse the specification with a warning notice.

The idea underlying the proposal is a valuable one, but is, nevertheless, open to some criticism. The endorsement of specifications as suggested might

conceivably have a double effect, as it might lead to an unjustified inference in the case of specifications not so endorsed, that such specifications were, in fact, sufficient. I observe that the Committee, in paragraph 21, themselves admit that it is difficult to justify the requirement as to sufficiency in the case of patents for processes owing to the fact that at the date when the patent is applied for, the importance of some of the factors in the patented process may not be clearly apprehended by the inventor In these circumstances it seems somewhat hard that an inventor should have to run the risk of having his patent endorsed with a warning notice, which notice would undoubtedly very seriously affect the commercial value of the patent. Furthermore, every patent specification must, of course, be read in the light of common general knowledge, which means the common general knowledge of those engaged in the art. It seems to me doubtful whether in all cases the examining staff of the Patent Office would have sufficient practical experience of the subject matter of the patent to justify the somewhat drastic expedient of endorsing a specification with a warning notice as suggested. The fact that, in the opinion of the Committee, which is no doubt justified, the recommendation would be exercised in a reasonable and not in a vexatious manner, is reassuring, but does not completely meet the difficulty.

Biological Inventions.

I now pass to the recommendations made by the Science Guild with respect to the extension of the protection of the patent laws to inventions which are at present unpatentable. Under this head the Report treats only of inventions, such as biological inventions which are at present unpatentable, on the ground that they do not constitute a manner of manufacture under the Statute of Monopolies. I propose, however, to include under this head also the recommendation to establish a system of short term patents. In my view the importance of the recommendation made in regard to short term patents lies not so much in the fact that they would be obtainable more promptly and cheaply than full term patents, but because their validity could not be impeached on the ground of absence of subject matter.

The limitation of the grant of patents to inventions relating to a " manner of new manufacture " is derived from the Statute of Monopolies. In the introduction to the Report, the importance of the growth in scientific knowledge arising from research in pure science is very properly emphasised, and it is pointed out that not only the volume of invention but also its trend has been completely altered by modern research, notably in the chemical and biological sciences The limitation of the definition of patentable inventions to which I have referred has had the effect of rendering it practically impossible to protect by means of patents biological inventions of value, particularly in the agricultural industries. In the Report rust-proof wheats and new applications of parasites for destroying weeds are cited as examples.

Whether the present depression in our agricultural industry is in any way due to the fact that improved biological products are at present unpatentable, is somewhat doubtful. But there can be no little doubt that if biological inventions were freely patentable, more capital might be unloosed to further agricultural progress. Considerable difficulties would necessarily be encountered in devising any means whereby such patents might be rigidly enforced, but the enforcement of such patents is a matter which, as suggested in the Report, might fairly be left to the test of time. Apart from biological inventions, there are also other inventions of a useful nature, which are at present unpatentable owing to the words of Section 6 of the Statute of Monopolies. I refer, for example, to processes involving electrical action at a distance. The British Science Guild only refer in their recommendation to biological inventions, and whilst agreeing that such inventions should be patentable, I venture to express the view that there are also other inventions which are capable of commercial exploitation and for which protection should be ensured by some amendment of the present Act. With regard to biological inventions concerning medical treatment, I observe that in the Report it is suggested that in view of the strong contrary opinion of the medical profession these should not be patentable. Personally, I doubt whether the fact that the medical profession is opposed to the grant of such inventions should be regarded as conclusive

If any amendment of the Act be introduced on the lines suggested in the Report, an attempt should be made to secure such amendments of the International Convention as would enable the protection for the inventions contemplated to be extended to other countries

Short Term Patents.

Now I must deal with the question of the desirability of the introduction in this country of a system of "short term patents," analogous to the system of "Gebrauchsmuster" established in Germany in 1891. I believe I am correct in thinking that Germany is the only country which so far has introduced a system of the kind. The difficulty with which the British Science Guild is attempting to deal arises from the fact that intermediate between inventions protected by patents and industrial designs which are at present protected under the design provisions of the Patents Acts, there is a further class of invention which at present lacks protection. Under the design laws one can only protect such features of shape, configuration, pattern or ornament which as applied to any article by any industrial process appeal to the eye, and such protection does not extend to any mode or principle of construction or anything which is in substance a mere mechanical device. The class of articles which the British Science Guild has in mind includes, for instance, utensils, tools, or machine parts of novel and convenient shape and machines of known types having a novel layout of component parts. Under the existing system the protection of such articles is difficult. If protected under the patent laws

many such articles, although new and useful, may, according to the Report, not have sufficient subject matter to justify the grant of protection. If protected as designs they are only protected in so far as their external shape or configuration is concerned.

Apart from these two difficulties there is also the third difficulty that if application be made for protection under the patent laws, so long elapses before the patent is accepted that in the case of many of these articles, the success of which is dependent upon quick sales, the protection when eventually obtained is too late. The articles in question are articles which can be quickly copied, and as no damages can be claimed by the patentee prior to the date of the acceptance of his complete specification, unscrupulous competitors do not hesitate at once to place infringing articles on the market. This difficulty is particularly felt by the manufacturers of seasonal articles, such as, for instance, mechanical toys which are sold in such large quantities during the Christmas season.

It is proposed by the British Science Guild that protection should be granted for this class of article by means of what are termed "short term patents," which patents should not be liable in the same degree as full term patents to invalidation on the ground of lack of subject matter, it being generally sufficient that the innovations protected by them be new and useful. The term of protection proposed is a term not exceeding seven years. It is suggested that the grant of such patents should be prompt and cheap, and that their scope should be narrow and restricted; the claims, for instance, being restricted to one or two in number, each claim ending with some such phrase as "substantially as described and shown in the accompanying drawings." It is not clear from the Report whether it is intended that short term patents should be subjected to any search as to novelty before grant but I assume that there would be no search, as the proposals involve a prompt grant of protection.

I have no doubt that the chief objection which will be raised to the proposal will be directed to the suggestion that monopolies should be granted in respect of any invention which is devoid of subject matter. Indeed, reading between the lines, it seems as if the members of the Committee of the British Science Guild themselves were not fully convinced of the desirability of this condition. I say this because in defining the privileges to be granted to short term patents the Committee does not in terms state that no degree of inventive ingenuity shall be required. The words used are these: "British short term patents shall not be liable *in the same degree* as full term patents to invalidation on the ground of lack of subject matter. It should *generally* be sufficient that the innovation be new and useful." No information is given, however, as to what is meant by the words "in the same degree" or the word "generally" in the passage to which I refer. It is difficult to understand the effect of the words "in the same degree" if indeed it is intended that they should have any

meaning at all, because under recent decisions of the Courts in certain patent cases even a scintilla of invention is sufficient to support a patent which is new and useful. Thus in the case of Guisti's Patents, reported in 40 R.P.C., page 206, Mr. Justice Astbury, in dealing with an infringement action relating to a patent for tin openers, said this: "I care not how simple it is if it is not an obvious thing, and if the production of it was not a mere workshop improvement on a well-known tool. If it involved invention, *however slight*, I think the patent ought to be supported, and it must be borne in mind that the claims of the patentee do not cover any article proved to have been previously made or described."

The case to which I refer is specially relevant because the invention in question was in respect of a tin opener, that is to say, one of the class of articles which the Science Guild proposes should be covered by short term patents.

The decision seems to me to cast some little doubt as to the necessity for the condition proposed in the Report as to "absence of the same degree of subject matter" In the case of a humble invention the Courts already seem to be satisfied with a considerably less degree of subject matter than appears to be requisite in the case of complex inventions.

I must confess that I am in agreement with the view that some amendment of the law is required to facilitate the protection of small but useful inventions of the class referred to I have serious doubts, however, as to the desirability of the method proposed by the Science Guild for achieving that object. It is possible that one effect of the introduction of short term patents would be unduly to restrict the development of his invention by a patentee who has protected his invention by an ordinary patent. It seems to me probable that on the publication of the specification of an important patent many attempts would be made by third persons to protect obvious variations in the constructional form or arrangement of the machine by means of short term patents. The use of any such variations might well come within the ambit of the claims of the original patent, so that their use could be restrained by the original patentee, but the original patentee would not himself or by any of his licensees be entitled to use any of the particular variations which happened to be protected by these short term patents without paying a royalty to the owner of such short term patents, even though the variations protected were perfectly obvious and involved no inventive ingenuity of any kind. This danger could not be easily guarded against by any amount of care in the drafting of the original specification of the letters patent of the main invention, and a prudent patentee would therefore be obliged to supplement his original application by a large number of short term patents, thereby very materially adding to his overhead expenses.

Secondly, there is the difficulty arising from some of the general considerations to which I referred in the opening paragraphs of my paper. It might very well be that the introduction of the system in Great Britain might be followed by the

introduction of similar systems in many other countries. If that happened, a British manufacturer who desired to incorporate some small variations into his patented machine, produced perhaps on mass production lines, would be bound to incur the very great expense involved by searches in a large number of countries, before he could be certain that the variations could safely be made use of.

At the same time I feel the force of the argument that the system has been in force in Germany for nearly 40 years, and that every year nearly 51,000 Gebrauchsmuster are applied for. I also recognise that Germany is the country which has specialised in the manufacture of novelties and small tools and has built up a very valuable trade in such articles, and it may be that there is some connection between the growth of this particular trade in Germany and the establishment in that country of the Gebrauchsmuster system. Whether this is so or not I am unable to say. The fact that Gebrauchsmuster are applied for annually in such large numbers may on the other hand be due to the fact that ordinary patentees have found themselves obliged to supplement their patents by Gebrauchsmuster for their own protection.

In any event, I feel that a very careful enquiry should be made into the actual operation in Germany of the Gebrauchsmuster system before any similar system is introduced in this country.

The difficulty arising from the fact that in some cases, as for example, seasonal goods, the present patent delays render ordinary patent protection quite useless can be met in other ways than by the introduction of short term patents. Thus an amendment of the law might be introduced enabling damages for infringement to be recoverable in respect of infringements committed before the publication of the complete specification, provided that the patentee is able to show that the infringer had notice that an application for patent protection was pending.

Legal Proceedings.

I am afraid that as time is short I can deal only very briefly with the recommendations made with a view to reducing the cost of patent litigation. I must, however, refer to the very important suggestion that patent actions should be tried before the Comptroller, and that appeals from the Comptroller should be to a special Judge in Chambers instead of to the law officer as at present. I can see no real reason why infringement proceedings should not, with the consent of the parties, be heard by the Comptroller. In some cases the expense of such hearings might not be very much less than the expenses which would be involved in High Court proceedings, but in such cases the parties would probably prefer in the first instance to proceed in the High Court. There are many cases, however, in which a patentee is deterred even although he has a valid cause of action from taking proceedings, owing to the very great expense usually involved in patent proceedings in the High Court. In cases of this kind the suggestion made by the British Science Guild has particular force.

No reference is made by the Guild to the issue of certificates of validity. These should not, I think be granted by the Comptroller, but should be reserved for High Court judges. Subject to that exception, however, I can see no valid argument against the proposal. I am also strongly in favour of the suggestion that appeals from the Comptroller's decision should be heard by a special judge. The present procedure has obvious difficulties, as has been admitted on many occasions by the Law Officers themselves, particularly in cases in which technical questions are involved. It has been suggested that, the granting of patents being a prerogative of the Crown, appeals should constitutionally only be heard by a law officer of the Crown. Historically, this may be perfectly correct, but the argument carries little weight when the present practical difficulties are considered.

Whilst I am dealing with the question of legal proceedings I ought perhaps to refer also to the recommendations in the Report regarding the remedy available in the case of unwarranted threats of legal proceedings for patent infringement. The present Section is undoubtedly insufficient, because there is no remedy for threats based on a provisional specification or on a complete specification before the date of sealing, and furthermore the threatener can escape retribution by beginning an infringement action with due intelligence, even if he abandons it as soon as the defence has been put in. I strongly support the suggestion made by the British Science Guild that Section 36 should be amended so as to cover these cases.

Patent Office Delays.

I have already referred in an earlier part of my paper to delays which occur at the Patent Office in dealing with patent applications The suggestion made by the British Science Guild that when an indisputably complete anticipation has been found, time should not be wasted in collecting further references is useful, but would, of course, not have much effect on the present delay. I doubt also, whether the institution of a system of short term patents would relieve the present congestion—in fact, it might conceivably add to it, as I observe that in Germany the number of patents deposited annually has not been materially affected by the establishment of Gebrauchsmuster.

The only remedy is an increase in the strength of the examining staff. In the Report figures are given which show that whereas in the last 16 years the number of complete specifications filed has increased by 26.2%, the strength of the examining staff has decreased by 9.9%. Since the Report was written further figures are available which show that whereas on July 18th, 1928, 6,300 complete specifications were awaiting first action, the arrears were accumulating at the rate of 67 per week. On February 26th, 1929, the arrears had amounted to 8,400, and were increasing at the rate of 76 per week. The position is a serious one for British industry, and should be remedied without delay. As the British Patent Office is being administered at a handsome profit, there is little reason

for these delays, which could no doubt be considerably reduced with the co-operation of the Treasury.

There are two further matters referred to in the Report, which I must now deal with, viz., the question of the obstructive use of patents, and the various proposals put forward by the Science Guild under Section C of the Report entitled "Applications for Patents."

Compulsory Working

I am rather inclined to the view that, in considering the question whether insistence upon working is in principle desirable, manufacturers as a whole are somewhat inclined to overlook the very serious difficulties which arise owing to the obvious impossibility of working any particular invention in all countries simultaneously. It may be that the working provisions of our Act do in some cases result in licences being granted to British firms to work in this country foreign-owned patents, but the grant of licences to British firms could be secured in other ways than by insisting on working If it be pointed out that the whole object of the patent laws is to ensure the establishment of new industries in the United Kingdom, the reply might be made that if the necessity for working were abolished by international arrangement it might be possible for British manufacturers to set up factories in this country for the purpose of working other inventions which it would be quite uneconomic to establish if working in other countries were necessary. The commercial success of any invention depends ultimately upon the number of customers available, and if the potential customers are artificially restricted it may well be that the invention may never be put into practice at all. If the whole of Europe were a free territory so far as working clauses are concerned, in the same way as the vast territory forming the United States is at present a free territory, owing to the fact that it is within the one jurisdiction, it might well be that new industries might be established in the United Kingdom under British patents worked by British capital, goods from the said factories being exported to all the European countries without fear that the fact that such goods were manufactured in Great Britain and nowhere else could be used to invalidate any of the patents under which the invention was patented abroad.

I am not, of course, suggesting that the obligation to work should be abolished in this country unless similar amendments are introduced in the laws of foreign countries, but it is not, I think, out of place in this paper to refer to reforms which may be desirable even if they can only be achieved by international agreement. Pending unanimity it might be possible to amend the English law in such a way that working in this country of patents granted to foreigners should be dependent upon the principle of reciprocity. The interests of the public could be secured by the insertion in the Patents Acts of provisions enabling the Comptroller to grant compulsory licences in cases where the

articles protected by the patent are not made available to the public at reasonable prices.

The question now discussed is really an economic question and must be decided by manufacturers themselves. It is a matter, however, which in my opinion is worth reconsideration. I presume that it was fully considered in 1919 when the Patents and Designs Act of that year was passed. At that time, however, all decisions were largely influenced by the events of the five preceding years, and many decisions were taken in that year which have since been regretted

Application Formalities

In the chapter dealing with applications for registration I observe that the British Science Guild have adopted practically in toto the recommendations recently made by the special Committee appointed by the Board of Trade to consider the question of the dating and sealing of British patents. That Committee recommended that the maximum period allowed for filing a complete specification after a provisional specification should be increased to twelve months, and that the duration of protection should be calculated from the date of the filing of the complete specification It also proposed that Convention applications should be treated in a similar manner, the duration of a Convention patent being calculated from the date of the filing of the application in this country and not from the date of the original application in the foreign country as heretofore The principle underlying the recommendation was that the filing of the original foreign specification should in the case of a Convention application be regarded as if it were a provisional specification filed under the British Patent Acts Certain other recommendations were also made by the Dating and Sealing of Patents Committee with regard to the date of the throwing open to public inspection of specifications filed in this country under the Convention At the present time a British specification is not published before acceptance, and the period allowed for acceptance is fifteen months, with a possible extension on payment of fees up to a total of eighteen months. A Convention specification is, however, thrown upon to public inspection on the expiration of twelve months from the date of original application in the country of origin The Dating and Sealing of Patents Committee recommend that no distinction should be made as between national and Convention applications in this respect.

It seems to me curious that the British Science Guild should not have referred in its Report to the proposals of the Dating and Sealing of Patents Committee as to dating or to the fact that, assuming that the present period of sixteen years were retained in the British Acts as the period of duration of a patent, one result of the acceptance of these proposals would be to extend the effective duration of all British patents by a year. Such an extension would, I think, be welcomed by British patentees, though it would only affect

comparatively few patents out of all the number of patent applications made, due to the fact that the vast majority of patents lapse long before the sixteenth year owing to failure to pay the renewal fees. The British Science Guild, however, suggests that it might be as well to introduce no change in the British practice with regard to the publication of Convention applications until foreign nations are prepared to make reciprocal concessions as regards third party rights. The reason why this proviso was introduced is no doubt because a similar proviso was inserted in their recommendations by the Dating and Sealing of Patents Committee. I very much doubt the wisdom of deferring the reforms proposed for the reason given. Under the terms of the International Convention it is provided that patents applied for in the various countries by subjects of the contracting countries shall be independent of the patents obtained for the same inventions in the other countries as regards their nominal duration. The practice of ante-dating a Convention patent to the date of original application in the country of origin is peculiar to Great Britain and some of her Colonies, and the other Convention countries have always complained that the British practice of ante-dating and throwing open to inspection of Convention applications involves a breach of the spirit if not of the terms of the Convention, to which Great Britain is a party, and it was this complaint, renewed at the Hague Conference of 1925, which resulted in the setting up of the Dating and Sealing of Patents Committee.

It is true that certain foreign countries which permit their own nationals to acquire what are known as rights of personal possession during the interval between the date of application in the country of origin and the date of application in those countries by foreigners under the Convention, are themselves equally, if not more, guilty of a breach of the spirit of the Convention. Nevertheless, it seems to me invidious for any one country which is regarded by its fellow contracting countries as acting in breach of Convention to make the remedying of the breach in any way conditional. There is also much to be said for the view that if Great Britain were at once to alter its practice in this respect to conform with the views held by practically every other Convention country, it would be able at the forthcoming London Conference to exercise very much greater influence on Italy and Hungary, which are the two recalcitrant countries so far as third party rights are concerned.

Quite apart from the international aspect of the question, however, the proposal that the period between the filing of the provisional and complete specification should be extended to twelve months so as to coincide with the priority period under the International Convention would be of considerable value to British patentees. I am assuming, of course, that at the same time the period allowed for acceptance is increased as suggested to eighteen months with extensions up to a total of twenty-one months.

I think, however, that if there is a limit placed on the time within which an applicant must get his application accepted, a definite limit should also

be placed on the Patent Office within which to take the necessary Office action.

I doubt the wisdom of insisting on throwing open to public inspection applications which have not been accepted, even if advantage be taken of the full extended period proposed.

A further suggestion made by the British Science Guild that it should be permissible to file under the International Convention a single British application in respect of two or more foreign applications relating to cognate subject matter seems to be sound, and would follow the acceptance of the principle underlying the recommendation of the Dating and Sealing of Patents Committee that applications for patents abroad should be assimilated with British provisional specifications. This is a question, however, which ought to be dealt with by the International Convention itself

I might add that this particular recommendation received the full support of the International Chamber of Commerce, who in 1925 suggested the inclusion in the International Convention of a similar provision Whilst I am dealing with a question which refers to the International Convention it would perhaps not be out of place to allude to one further matter which is not dealt with by the British Science Guild, but which creates difficulties in connection with applications made in this country under Section 91 of the Patents and Designs Acts.

Under that Section a foreigner is entitled within twelve months to apply in this country for protection in respect of any invention " for which protection has been applied for in the foreign state." Difficulties have arisen with regard to the interpretation of the words " for which protection has been applied for in the foreign state " The principle underlying the International Convention is that for the purposes of priority an application for protection in a Convention country shall be regarded as having been made simultaneously in all the other countries of the Union. In some countries it is not necessary that any specification should be accompanied by detailed claims. Under British practice, however, protection is refused in respect of a Convention application if the invention claimed in this country is larger than the invention actually claimed in the country of origin, even although the invention claimed in this country is in fact fully described in the body of the specification originally filed abroad. The British practice is, in my view, contrary to the spirit of the Convention and should be amended, and protection in this country should not be refused merely because the British claims do not coincide with the claims filed abroad.

There is, I am afraid, insufficient time for me to deal individually with all the other matters dealt with in the Report of the British Science Guild. These deal inter alia with the post dating of applications, the conversion of a complete into a provisional specification, disconformity, the extension of time in opposition and revocation proceedings, and many other matters of no mean importance to patentees and others interested in the operation of the Patents Acts. There

are also a number of very valuable suggestions with regard to rendering more easily available to the public technical and other information in the possession of the Patent Office. I have not referred to them because the Report itself is readily obtainable by any person interested, and I have no special comment to make with regard to those recommendations except to approve generally of them.

British inventors and manufacturers interested in patents are very much indebted to the British Science Guild and the very distinguished gentlemen who served on the Committee of that Guild, and whose deliberations have resulted in the Report with which I have been dealing to-night. The Report has aroused lively interest not only in this country but also abroad, and is now being carefully considered by many organisations which are interested in patent questions. I also believe that, as the result of the issue of the Report, the President of the Board of Trade has already consented to appoint a Committee to enquire into the operation of the British Patents Acts. When sufficient time has elapsed for the Report to have been properly digested by all the organisations which are now considering it, it would be extremely useful, if I may venture to make the suggestion, if the British Science Guild were to convene a national conference of all the organisations interested, so that the various suggestions contained in the Report may be further considered from all points of view and any divergent views brought into harmony.

DISCUSSION

THE CHAIRMAN said it was very fitting that they should have had such an excellent paper read before the Society of Arts, because, though probably most of those present would not remember it, the Society took a very active part in 1850 when the patent law of this country was improved.

MR. J. W. GORDON, K.C., said he had been very much interested, as he was sure they had all been, in the paper which had just been read. Patent law was, of course, a subject of paramount interest to a very large number of our manufacturers, it was also of interest to those who were the customers of manufacturers, because everything that facilitated the introduction of improvements into our manufactures was a matter, not merely of manufacturing interest, but of national importance. From that point of view any question which affected the terms or the administration of our patent law was of much more than merely technical interest and importance. The paper dealt with the subject in a manner that must, he thought, strike everybody as being singularly detached and able. Everybody would approach the report issued by the British Science Guild with a certain feeling of respect due to an expert body which was dealing with a subject of great technical intricacy as well as of great practical importance; the lecturer had discussed with great freedom the suggestions of that Committee, and had criticised those suggestions in a way which had the great merit of being not only independent and searching, but also of being distinguished by very good judgment. The value of any work which was intended for practical uses must depend to a very large extent on the criticism which it elicited; no body of people could be expected to sit down and

meditate upon a subject with however much industry and concentration and produce the best result; all the work, and especially all the technical work, that was done in the world was greatly improved by criticism. He had no doubt that the work of the British Science Guild would be very much improved by being subjected to criticism of the sort that had been given by the author. Nothing that he had said in his paper was unjust or captious; on the contrary, the free criticism of the report which had been put forward was, he ventured to think, the best way of dealing with a report of this kind. In view of the fact that he (the speaker) had not seen the paper before it was delivered, he would not venture upon any detailed additions or remarks on the subject matter of the paper. It was a matter in which he himself had been considerably interested for a long period, but his interest had not been that of the manufacturer; it had been a detached interest. It was therefore proper that he should limit himself to general observations. He desired to thank the author for his paper.

Mr. H. C. Haycraft (Assistant Comptroller, H.M. Patent Office) expressed the pleasure and interest which he personally had felt in listening to the paper. He was afraid it was impossible for him to take part in the discussion; his position at the Patent Office debarred him from doing so. He felt he might, however, say that the Patent Office was always prepared in a hopeful spirit to undertake any responsibilities which Parliament might think fit to entrust to them, their attitude being that it was "Theirs not to reason why, Theirs but to do or die", and he was inclined to think that the latter of those two alternatives might be their lot if effect were given to all the reforms of which the author had expressed approval.

Mr. H. A. Gill said that, though he was not in the same position as Mr. Haycraft, he was a little tied in other ways, having been a member of the British Science Guild Committee which had produced the report; anything, therefore, that he said otherwise than in favour of that report would hardly be received with approval. The author had criticised the report in several respects; he (the speaker) thought those criticisms were quite pertinent, and should be considered; they were not in any way unkind, but were merely calculated to ensure greater care in carrying out the recommendations of the British Science Guild, and that adequate safeguards should be provided. The author had apparently received an adverse opinion from Germany of the *Gebrauchsmuster*, or short-term patent system, in that country, it being said that a large number of those short-term patents were probably invalid. The facts, however, spoke for themselves; the number of these short term patents was steadily growing, very great use of them was being made by German manufacturers, and he (the speaker) had not heard of any complaint in Germany that such patents had been used, as the author had suggested, to obstruct the normal development of inventions of a patentable nature. The author had suggested that smaller manufacturers might be on the watch for big inventions coming out in order to produce minor inventions for which short-term patents might be taken out, with a view perhaps not of blackmail, but of making it difficult for the bigger manufacturers to work those substantial inventions without obtaining permission to use the minor inventions. He did not think that had been at all the case in Germany; on the contrary, these *Gebrauchsmuster* had filled a definite gap between the registration of articles merely with regard to external shape and appearance and the patenting of inventions. The procedure had been hedged about so as to make it impossible for undesirable practices to be resorted to. If such a system were introduced in this country it would be found that the Patent

Office would be relieved of a burden which was at present on its shoulders, because everybody was trying to register as designs for fifteen years things which should be of the short-term patent order.

Mr. A. Jaffé expressed his appreciation of the paper; he was very glad that the author, in the body of the paper, had gone beyond the title of the paper "The Reform of the British Patent System," in that he had pointed out the great importance of looking at this matter not from the insular but from the international point of view. We had moved very far from the days of the Statute of Monopolies, and it was more important than ever that the international point of view should be preserved.

Mr. B. E. Dunbar Kilburn said he had listened to the paper with great interest. Like Mr. Gill, he felt that his position was curious, in that he had been a member of the committee which produced the report upon which the author had commented. Those comments were extremely good; he would not be sorry if that Committee had an opportunity of reconsidering their report in the light of the author's remarks, but he supposed that was impossible. He desired to express his agreement with what Mr. Gill had said as to the short-term patents; he did not know that the author appreciated the extreme difficulty which was experienced in dealing with those inventions, if they could be so called, which were between designs and patents. As a matter of fact, there had been for a long time a demand for the sort of protection that was given by a short-term patent. Difficulties were also experienced in the registration of designs. The question had been discussed elsewhere, not many days before, in connection with copyright. The situation with regard to designs was unsatisfactory, and something ought to be done. He saw no reason why the short-term patent system should not afford a way out of the difficulty, at any rate, to a considerable extent. The author seemed to think there would be international difficulties with regard to short-term patents, he (the speaker) could not see why; in fact, he would go the length of saying that if short-term patents were introduced everywhere it would be advantageous; he saw nothing against it.

Captain C. W. Hume (British Science Guild) expressed his appreciation of the acute criticisms and lucid presentation of the paper; it was a paper which he was sure all those interested in this subject followed with the greatest possible interest. There was a good deal that he desired to say in detail, but he was in the unfortunate position of being already in "hot water" for the part he had taken in preparing the report, and was unwilling to commit any further indiscretions because he saw around him several of his official superiors from the Patent Office. He only knew of two books dealing with the economics of the patent system; one was an American book and dealt with the American patent system, while the other was a book by Mr. A. F. Ravenshear, whom he was glad to see present, and who in 1908 gave the subject a most careful and lucid analysis. It was, he thought, obvious to everybody that inventions had an intimate bearing on unemployment; that was illustrated by the Luddite riots on one side, and by the enormous employment which had resulted from such inventions as that of artificial silk, on the other side. Mr. Ravenshear had analysed the effect of a good patent system on employment; he (the speaker) would not say more than this, that he thought Mr. Ravenshear proved that a good patent system was a great benefit in relieving unemployment, whereas a bad patent system was, of course, bad for everybody.

He did not wish to express any opinion as to whether the British system was good or bad or could be improved, but he did wish to emphasise the importance of having it as good as it could possibly be.

DR. ARTHUR HAYDON said he desired to discuss the matter not so much from a legal or economic point of view, but rather from a scientific point of view. He thought it would be as well to have a few definitions of what substances could be patented; he was thinking of patent medicines and substances such as "pneumosand," which was really a preparation of tuberculin for the treatment of consumption and other diseases. If it were not considered irrelevant, it would be interesting if the lecturer could give them some opinion as to what substances were clearly outside the region of the Patent Office.

MR. JOHN HETTINGER thought the most important part of the paper was that dealing with short-term patents or *Gebrauchsmuster*, as they were called in Germany, and was very pleased to notice that that question was referred to by most of those who had taken part in the discussion. It was common experience that patents as to which patent agents had advised that there was no subject matter in them, were passed by the Patent Office, who seldom could refuse the grant, only to be subsequently found invalid by the Courts. The position was especially serious in connection with wireless apparatus. He had frequently been advised by counsel that patents on wireless apparatus which had been passed by the Patent Office had, in fact, no subject matter, and yet the articles were very successful in practice and exhibited at the Olympia Exhibition by a large number of firms. What was the position in such a case? They had an article which was undoubtedly new and was of proved utility, and yet everyone said it had no subject matter. He thought the Patent Office very well knew that a good many patents were granted for subjects which were not really subject matter for a patent. He submitted that the introduction of something intermediate between a patent and a design was good common sense. The author had received information from Germany to the effect that manufacturers did not like the *Gebrauchsmuster* system. The information which he (the speaker) had obtained was to the contrary—that they did like it. One point had been overlooked in the discussion: a good many of the *Gebrauchsmuster* were filed simultaneously with the patent application, the reason being that the *Gebrauchsmuster* was registered within two to four weeks; if it was an article such as was used in wireless, for instance, it could be put immediately on the market and infringements could be stopped. The author had pointed out a difficulty which might arise between the *Gebrauchsmuster* and the ordinary patent, that somebody might obtain a patent with a good wide claim, and then other people might come along and file any number of *Gebrauchsmuster* with practically no subject matter. But the holder of a valid patent could stop infringement or exact a royalty; on the other hand, there was no need for the patentee to file any number of *Gebrauchsmuster* if there were so many obvious imitations. He therefore repeated what he had said in the beginning of his remarks, that so far as the *Gebrauchsmuster* was concerned it was a commonsense proposition and a necessity. He had dealt with the present unsatisfactory position, and the remedy by way of "Utility Patents," in a short article published in the *Electrician* (p. 253), of August 26th, 1927.

MR. A. H. DYKES said that although he was exceedingly interested in patents and had committed the indiscretion of taking out a fair number himself, he did not claim to be an expert in Patent law. He did, however, desire to allude to a

point which was, he thought, germane to the discussion, although it did not directly bear on it. The object of reforming the patent law was, he took it, to encourage research and invention ; the best way to do that was to see that those who devoted their time to that research and invention reaped the reward of their work. There was one subject which he had taken up more than once ; he had taken it up with the Comptroller of the Patent Office, and also with *The Times*, which had been good enough, a year or two before, to take up the matter and comment on a letter he had written : it was that a very large proportion of patentees were not very wealthy men ; when they got out a patent they very frequently spent what was to them a very large sum of money in preliminary work ; finally, they possibly got their patent taken up on a royalty basis. But directly they received their first royalties the income-tax people came down on them, charging them income-tax on those royalties at the unearned increment rate. He submitted that was absolutely wrong, because if ever there was an income properly earned it was an income from patent royalties. The inventors were not allowed to deduct for income-tax purposes preliminary expenses to which they might have been put before they got those royalties ; an inventor might have spent £500 or £1,000 on preliminary expenses, but when he got a £5 royalty he was not allowed to set off against that his expenses ; he had to pay income tax at the full rate on that amount.

MR. F. F. TOWLER said there was one aspect of what the author called the extension of patentable subject matter which should be given a little further consideration than it had received. The report of the British Science Guild recommended—and the author appeared to agree with the recommendation—that there should be an extension of patentable subject matter in the direction of allowing, for instance, biological inventions to be patented ; but with regard to such inventions he was unable to see that there would be any consideration that the patentee could give for the grant of a patent. That had also struck him with regard to some things which were actually patented at the present time ; for example, inventions in connection with the production of substances by means of particular bacterial cultures. If a man produced, say, a rustless wheat nobody was going to go to the trouble of reproducing that same wheat when once it had been produced ; it would always be simply reproduced in the ordinary biological way by the seeds of the parent plant ; all that the patentee could give in his specification would be an account of the manner in which he had produced that particular species or variety. Whilst that account might be of considerable value to future biological research, there would be nothing in it that would enable the public at the end of the monopoly to produce what the patentee himself had produced. That same consideration held good with regard to the production of certain substances by means of bacterial cultures ; the patentee would describe how he obtained the particular bacterial culture, but it was not to be supposed that anybody would take the trouble to produce that particular strain of bacteria again ; he would simply carry on his work with some that he had produced from the strain that had already been isolated.

MR. H. J. NEILL desired to say a few words on one point which had not been dealt with except by the author ; that was, the proposed extension of the Patent Office official search to cover more than British patent specifications. Any search for novelty meant a search to find out that there was not anticipation ; such a search could never be conclusive because it would be manifestly ridiculous to suggest that every printed document in the world could be examined. The consequence was that the best a search could do was to give a reliable indication

of the state of the art or industry. The search that was at present made by the Patent Office afforded a very good indication of the state of the industry in this country. Further investigation and research, particularly foreign investigation, would involve patentees in very considerable expense in obtaining their specifications; it would mean the obtaining of foreign specifications, which was not easy, and their translation. For those reasons he thought the extension of official search beyond the British specifications would not, by the benefit it gave, justify the additional expense on the part of the Patent Office, and the additional trouble to which the patentee would be put. If the patentee wished to assure himself by the very best advice that his patent was going to be valid, he could have conducted on his behalf a search as expensive as he liked, and if he thought his invention was worth such expense, he would do so. To extend the scope of the official search would be putting an unfair onus on the patentee. He thought another point had not been appreciated in the remarks that had been made on the short-term patents for utility models. Some time before he had had a long talk with two German patent agents on this subject, and had come to the conclusion, as the result of what he had heard from them, that the requirements of subject matter or inventive ingenuity for obtaining and holding valid a German patent were very much higher than the requirements for obtaining patents in this country; the requirements for holding valid a German *Gebrauchsmuster*, although not quite as high as the requirements for holding a British patent, were getting on that way. A British patent at the present moment was granted and could be held, as had been pointed out by the author, on the merest scintilla of invention. Were we going to grant any form of patent for anything lower than that? If in this country we were going to have these short-term patents, it seemed logically to follow that the requirements for a full-term patent must be a really substantial invention, it probably being a requirement, as it was in Germany, that it should be for doing something new, and not merely for doing an old thing in a different way. Before a petty or short-term patent system could be introduced into this country, it would be necessary to alter by some means or other the requirements for validity of the full-term patent which would have to be of more substance than they were at the present time. If that were done, there was undoubtedly room for the utility model patent, but with the requirements as to subject matter which the Courts now imposed, there was absolutely no room for anything of smaller subject matter, and particularly of less inventive ingenuity.

The Chairman said they had had a very interesting discussion; he did not want to add much, because criticising the paper would be rather like reviewing an encyclopaedia. He merely wished to mention one or two points which he did not think had been mentioned. There was the question of the Comptroller acting as a Judge in these cases. Just at present they happened to have extraordinarily good men at the head of the Patent Office, but some of those present had memories, and perhaps it would not always be as it was now. But, even at the present time, the Patent Office officials had as much work as they could possibly do. Apart from that, the principle was fundamentally wrong. People who were to exercise judicial functions should be trained as lawyers, should be capable of weighing evidence, and should really have the sort of training that a Judge had. It had often been suggested that it would be a good thing for patents to be referred to arbitrators; he submitted that that was entirely wrong, because the arbitrator had to be an expert, and experts had not always the judicial capacity which was necessary in dealing with a patent.

The next point was that of compelling patentees to work their patents in the country in which they were protected. They might think he was a Liberal, or something dangerous of that sort, but, as a matter of fact, he was not a politician at all; he was a student of economics, and wished to point out that the idea of working patents in the countries in which they were protected was really bad economics; it was a form of protection and was really derived from the fundamental errors at the basis of protection.

He was afraid he would be against the general feeling of the meeting with regard to small patents. The original idea of the patent was that the State gave to a man a monopoly if he had produced something for the nation that otherwise would not have been introduced to the nation for at least sixteen years; but now we were trying to give a man a monopoly for producing something which somebody else would probably introduce next week if he were left alone. In that way the nuisance to manufacturers was very serious indeed. In America, for instance, a car might be produced by mass production, to alter that method of mass production was a very expensive process. By the time the car came out, the manufacturer might find that somebody had patented half a dozen little gadgets which were of no real importance, but which patents happened to cover something which had for convenience been used in the production of his car. That was a very serious nuisance, and the same sort of thing was going on in England. There was no real reason why a man who invented some little improvement such as a draughtsman was in the habit of producing every day of his life, should have a patent and be able to annoy other people with it.

Mr. Robert Burrell, in reply, acknowledged his very grateful thanks to Mr. Gordon and all the other speakers who had made such kind references to the paper. With regard to what Mr. Haycraft had said, he had to confess that it was somewhat news to him to know that the Patent Office was a body which regarded things with such resignation; he was also surprised to know that the Patent Office was always so prepared to do what it was told to do; in his own experience unfortunately there were many occasions on which he had asked them to do something and they had done the very opposite. Mr. Haycraft had rather suggested that the position was one of either doing or dying; the reason why he (the speaker) had supported so many suggestions in this report which imposed additional work on the Patent Office was because he had at the same time suggested that new life should be put into the Patent Office by means of vigorous reinforcements.

Mr. Gill had been rather tied, and had not been able to deal with the subject with the freedom with which, of course, he would have dealt with it had that not been so. He had, however, referred to the question which excited most interest in the report, namely, the question of short-term patents. He (the speaker) had received information from one source as to the way in which the *Gebrauchsmuster* were regarded in Germany; another speaker had then said that his information was quite the contrary, it seemed to him, therefore, obvious that the one thing they should certainly do before they went any further was to find out definitely what was the position in Germany. Mr. Gill had rather suggested that the system must necessarily be a good one because it was growing; but that did not follow. If the danger were becoming increasingly recognised, it might be that people would apply for more *Gebrauchsmuster* in order to defend themselves perhaps more vigorously than they would before. It did not follow that because a large number of *Gebrauchsmuster* were applied for they were necessarily useful. Mr. Kilburn had referred to the suggestion which he (the speaker) had made that there might

he international difficulties arising out of *Gebrauchsmuster*. What he had in mind was that this system might be established in a large number of countries. Some countries regarded their industrial property systems as a means of levying taxes; if it were seen that 51,000 *Gebrauchsmuster* were being applied for annually, it was always rather a temptation to use that method to supply the Exchequer with a little ready money. If that system were adopted in a large number of countries difficulties would arise, because at the present time a manufacturer who had to protect himself in the ordinary way by patent, protected himself in a large number of countries; if he had an obvious variation which did not involve any invention, *e.g.*, a commonplace addition to his machine, he did not worry to search all the files in foreign countries to see whether he could send that altered machine into a foreign country without infringing a patent. But if these short-term patents could be taken out in every country, it became a very serious matter; 51,000 of these short-term patents might be issued every year in each country; in seven years that would mean that there would be about 350,000 of these *Gebrauchsmuster* in any one country to be searched before any manufacturer could be certain that he could send his machine to that country.

He desired to express his gratitude to Captain Hume, because, as secretary of the British Science Guild Committee, he had been largely responsible for the lucidity with which the recommendations were stated. Dr Arthur Haydon had suggested that it would be desirable to put into the Act some definition of what would constitute a patentable invention; that suggestion was to some extent met by the report of the British Science Guild He had not time to deal with the particular question which Dr Haydon had in mind, but that raised another defect in our patent law, or at least drew attention to a Section of the Act which required further consideration, *viz.*, Section 38A, which dealt with patents for foods, and so on. It might very well be considered whether the word "special," having regard to a recent decision, should not be removed from that Section. He did not know whether Mr. Towler's suggestion, that there was no consideration for a patent with regard to a biological invention, was strictly true If an inventor showed an agriculturist how he could produce a rustless wheat, one would have thought that was of some use; he appreciated the difficulty of which Mr. Towler spoke, but would have thought that that might have been overcome by claiming not the first seed but the second. The Chairman had somewhat criticised the suggestion that the Comptroller should deal with patent actions, and suggested that we ought to be congratulated on the present state of things, but if it was desirable to have a lawyer as Comptroller, then if he were given judicial functions that was the very best way of ensuring that the next appointment, when it took place, would be that of a lawyer, and of one who had the particular capacity to which the Chairman had referred.

The Chairman had been the only speaker who had dealt with the question of working of patents in the countries in which they were protected He (the speaker) had feared he would be treading on many corns when he suggested the abolition of the working clauses; it had been rather a surprise to him to find that only one speaker had referred to that matter, and that speaker had been inclined to favour it. On the question whether it was a form of protection he was not prepared to go so far as the Chairman; but whether protection was a good thing or a bad thing was a matter quite apart; the point was that there was a tendency to prostitute the industrial property laws of this country for protection purposes. If protection were a good thing it should be secured by proper means and not by industrial property law.

He wished to thank the meeting for the kind way in which they had received the paper.

THE CHAIRMAN proposed a hearty vote of thanks to the author for his paper, which was carried unanimously.

MR. A. P. THURSTON, D.Sc., M.I.Mech.E., F.R.Ae.S., writes:

I did not have the opportunity of reading before the meeting the very interesting paper of Mr. Robert Burrell or of joining in the discussion, but the subject of the paper is of such great interest that I should appreciate the opportunity of making a communication.

The chief criticism against the paper appears to reside in the fact that sufficient regard has not been paid to the rights of the inventor and to the fundamental object of the British Patent Law, which exists for the purpose of improving the arts and the manufactures of the realm by encouraging the inventor and thereby raising the standard of living of the whole nation. It is not for the purpose of enabling large vested interests to acquire new inventions for nothing or a few pounds and then to hold the nation to ransom for enormous sums under patent monopoly, as may be done at present. Neither is its object to enable the use of obsolete, inefficient, or out-of-date processes to be continued by suppressing more efficient and improved processes.

The object of the Patent Law is to reward ingenious men for contributing the product of their own brains, their own intellectual property to the starting of new arts and manufactures. This side of the question, which seems to be of immense importance from the point of view of prosperity of the country as a whole and the cure of unemployment in particular, appears to have received little or no attention in the paper. Under the existing Patent Law it is possible for an inventor to communicate his invention to Government Departments, various manufacturers, all in confidence, to be discouraged by the rebuffs which he receives, and to drop his patent; then it is possible for someone else, who has probably heard of his invention, to patent it and to obtain a perfectly valid patent for the identical invention and large sums of money from the Government and public at large.

The Law is so heavily weighted against the inventor who is not also a wealthy man, and against the start of new industries, that the manufactures of the realm are being retarded in a most unnecessary degree.

I would venture to suggest that in drafting any proposed reform of the Patent Law, more attention should be paid to the rights of the inventor in his own intellectual property, and to the essential foundation of Patent Law, namely that it is for the purpose of improving the arts and the manufactures of the realm by encouraging and rewarding the inventor. Many of the suggestions raised in the paper are of great interest, but their discussion at the present stage appears to be unprofitable until more attention has been paid to the aspect of the question raised in the foregoing remarks.

NOTES ON BOOKS.

BRITISH FLOODS AND DROUGHTS. By C. E. P. Brooks, D.Sc. and J. Glasspoole, M.Sc., Ph.D. London: Ernest Benn Limited. 10*s.* 6*d.* net.

Floods and droughts have many times in human history spelt disaster and death and though modern conditions of life have reduced their destructive powers, they are still of great importance.

The authors of this book are well known authorities; Dr. Brooks on climates of past times, and Dr. Glasspoole on rainfall in general. The book begins with an account of the rainfall of the British Isles, and the causes of persistent rain. These are various and seems at first sight sufficiently remote For instance our weather depends in great measure on the intensities and changes of position of the Azores anticyclone and of the Icelandic depression, and these are influenced by still more remote factors.

Chapter II is entitled "The Wet Year 1927 The Turn of the Tide The question has already been answered in the negative, for, in spite of a fine summer, 1928 was a year of more than average rainfall in the British Islands Since 1906, as the authors point out "only six out of 21 years have received a rainfall below the average" and "in 22 years we have had nearly 23 years rainfall." But no year in the present century was as wet as 1903, "the year with two wet spells." So wet was it that in 100 years it was only exceeded by 1852 and 1872. As a whole the seventies of the last century were abnormally wet, and a chapter is devoted to them. When we go further back to "Historic Rains" we are dependent on chance records in various writers and chronicles, and the authors come to the conclusion that the period centred between 1000 A.D and 1400 A.D was one of excessive raininess It seems to us that chance references of old writers to droughts and floods must be used with great care Popular opinion of the weather is well known to be prone to excessive exaggeration, and much research may be needed before any idea can be reached of the sequence of climatic changes during the middle ages. But it is only fair to say that the authors attempt to get over this difficulty and in a note at the end of the book they give a method of calculation of "Raininess" dependent on the total number of records available, and the number of records of droughts and great rains respectively

Two pieces of evidence of greater weight, as it seems to us, are mentioned by the authors. Mr. G. M Meyer has studied water mills in East Kent and "has brought forward evidence of a decrease of rainfall about 1275"; for example in 1150 there were twelve water mills near Canterbury, in 1550 they had decreased to five. Again in Roman times villas are "found close to the highest springs of the winter-bournes, which run only in the wettest seasons," and at Woodyates in Dorset a Roman bucket was found at the bottom of a well 60 feet above the level to which modern wells have to be sunk in the neighbourhood

In considering droughts a chapter is devoted to each of the years 1921 and 1887 and another to the dry years of the 18th century when the dryness "was so marked and persistent as almost to constitute a different climate from that of the last half of the nineteenth and the beginning of the twentieth centuries"

In a chapter devoted to cycles of weather some indications are given of a maximum of raininess about 200 A.D, a minimum about 700 A.D, a second maximum about 1200 A.D. and a second minimum about 1700 A D.; but the authors warn us against a too hasty assumption of a period of a thousand years. Coming down to shorter periods seven cycles are considered, from one of 51 7 years down to one of 1.71 years. Fig. 15. combines these periodicities from 1870 to 1930 and gives the curve of actual rainfall. The two certainly give remarkable agreements, though at times they are "woefully at fault." The curve is continued till 1930, but we are told not to build too much hope on the drop in the curve of raininess after 1928.

The question as to whether we are likely to see a recurrence of the dry years from 1737 to 1750 "is one of vast importance, for if a single dry year like 1921, falling in the midst of a series of wet years, suffices to cause grave doubts as to the

sufficiency of the water supply of London, only the pen of a sensational novelist could adequately picture the effect of a long series of dry years on the, presumably greater, London of the future." The book is thus worthy of study not only for the meteorologist and the historian, but even more for its suggestions of the profound effects that may occur in relation to modern conditions of civilization.

C. J. P. CAVE.

LUNGE AND KEANE'S TECHNICAL METHODS OF CHEMICAL ANALYSIS. Second Edition. Edited by Charles A. Keane, D.Sc., Ph.D., formerly Principal of the Sir John Cass Technical Institute, London; and P. C. L. Thorne, M.A., M.Sc., Ph.D., Chief Lecturer in Chemistry, Woolwich Polytechnic. Volume II. London and Edinburgh: Gurney and Jackson. £3 3s. net.

The second of the six volumes of this monumental work has now appeared in its revised form, and new editions of the remaining four are in active preparation. It is now about twenty years since the first edition of the first volume was published in England, and the technique of analytical chemistry has advanced so rapidly in the meantime that the need for an overhaul will not be disputed.

The treatise is so well known to analytical chemists that but little general description need be given. This particular volume is devoted to the metals, both ferrous and non-ferrous; the metallic salts (with a large special section on potassium salts); paints and pigments; and paint vehicles, japans and varnishes.

All the sections have been thoroughly revised and brought up to date, the latest English and American methods having been incorporated; and the publishers explain that the arrangement of the contents has been modified by grouping correlated industries together, so as to make the volume very largely self-contained. It is well that this should have been done, and chemists will agree that the further this principle can be carried the better: those who do not happen to be professional analysts naturally find some hardship in having to purchase several volumes of such a treatise in order to deal with some problem whose various aspects could easily have been covered in one.

The references to original papers are numerous and well chosen, while most of the sections are provided in addition with valuable separate bibliographies. The index is sufficiently full, but one is glad to note that a separate index-volume to the whole work will be issued on completion of the new edition.

OBITUARY.

HEDLEY FITTON, R.E.—Mr Hedley Fitton, who died at his Haslemere home on July 19th in his 73rd year, was well-known as an etcher and draughtsman of architectural subjects. In his early days he was associated with the Daily Chronicle under Massingham and illustrated a number of articles by Frederic Harrison on Repair or Restoration. His work, in which atmosphere and texture, and richness of quality in light and shade were the distinguishing features, obtained early recognition both in this country and in France. He was awarded the Gold Medal of the Société des Artistes Français in 1907 and three years later became an Associate of the Société Nationale des Beaux Arts, while two of his etchings—the Rue Hotel de Ville and Ponte Vecchio—were selected from the Salon for the permanent collection at the Petit Palace. He was also elected a Fellow of the Royal Society of Painter-Etchers and Engravers, to whose exhibitions as well as to the Academy and the Salon he was a regular contributor. He had been a Fellow of the Royal Society of Arts for nearly a quarter of a century.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE TREATMENT OF COAL.

By C. H. Lander, C.B.E., M.Inst.C.E., M.I.Mech.E., F.Inst.P.,

Director of Fuel Research, Department of Scientific and Industrial Research.

LECTURE I.

(Delivered 21st January, 1929.)

In this generation of scientific, technical, and industrial achievement it is difficult to imagine a world ignorant of the uses of coal, yet its exploitation on a really large scale has extended over a relatively short period. In 1800 Great Britain's annual coal production amounted only to 10 million tons, but this rose steadily to a maximum of 287 million tons in 1913, of which 189 million tons was retained for home use. Following upon an abnormal period due to war and post-war conditions, the home consumption of coal has again reached almost its former maximum level, showing slight variations above or below a mean of about 175 million tons annually, although exports have seriously declined.

The following table, taken from the Seventh Annual Report of the Secretary for Mines, shows the manner in which this coal is employed. Roughly 20% of it is treated by carbonisation industries, nearly all of the remainder is burned in its raw state, much of it for steam-raising purposes. It is evident from these figures that whatever developments of new processes the future may see, the efficient utilisation of raw coal merits close attention.

TABLE I.

CONSUMPTION OF COAL IN GREAT BRITAIN.

Consumer.	1913.	1920	1922.	1923	1924.	1925.	1927.
	i. Quantity (Million Tons).						
1. Gas Works	16.7	16.88	15.18	15.38	16.66	16.45	16.97
2. Electricity Generating Stations belonging to authorised undertakings and to railway and tramway authorities	4.0	7.36	6.54	7.24	7.70	8.08	8.96
3. Railway Companies (for locomotive use)	13.2	13.42	12.19	13.33	13.51	13.36	13.58
4. Vessels engaged in the Coastwise Trade (bunkers) ...	1.9	1.28	1.18	1.16	1.27	1.16	1.18
5. Iron Works (Pig Iron)	21.2	18.80	9.51	14.41	14.23	12.03	13.45
6. Other Iron Works and Steel Works	10.2	11.82	8.00	11.29	10.34	9.26	
7. Collieries (engine fuel)	18.0	17.20	16.25	16.85	16.57	15.42	14.55
8. Domestic Coal, including Miners' Coal (approx.) ...	40.0	40.00	40.00	40.00	40.00	40.00	40.00
9. General Manufactures and all other purposes ...	57.7	53.00	48.91	49.10	60.08	53.81	70.89
Total	183.8	180.72	157.70	168.70	180.36	169.57	179.58
	ii. Percentage Proportion of Total.						
1. Gas Works	9.1	9.4	9.6	9.1	9.2	9.7	9.5
2. Electricity Generating Stations belonging to authorised undertakings and to railway and tramway authorities	2.7	4.1	4.2	4.3	4.3	4.8	5.0
3. Railway Companies (for locomotive use)	7.2	7.4	7.7	7.9	7.5	7.9	7.6
4. Vessels engaged in the Coastwise Trade (bunkers) .	1.0	0.7	0.7	0.7	0.7	0.7	0.6
5. Iron Works (Pig Iron)	11.5	10.4	6.0	8.5	7.9	7.1	7.5
6. Other Iron Works and Steel Works	5.5	6.5	5.1	6.7	5.7	5.4	
7. Collieries (engine fuel)	9.8	9.5	10.3	10.0	9.2	9.1	8.1
8. Domestic Coal, including Miners' Coal (approx.) ...	21.8	22.1	25.4	23.7	22.2	23.6	22.3
9. General Manufactures and all other purposes ...	31.4	29.0	31.0	29.1	33.3	31.7	39.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The application of the numerous types of coal to the purposes for which they are best suited entails a knowledge of their physical and chemical characteristics, a full understanding of which depends upon the elucidation of the constitution of coal. This is being sought after in several ways, including chemical analysis, microscopical examination and the use of X-rays, certain aspects of each of which will be considered briefly.

Chemical analysis, in addition to its use for scientific requirements, has a wide field of application in connection with the buying, selling and commercial utilisation of coal. For all purposes a certain standard of accuracy is desirable. It is well known that the figures obtained by different workers for the same determination frequently show wide variations due to differences — either fundamental or of detail—in the methods employed. In order that all the results of any determination may be of the utmost value it is essential that the methods employed shall be, if not identical, at least capable of giving comparable results. In this country the Fuel Research Board, feeling that some degree of agreement upon methods was desirable, in 1921 appointed a committee to examine the whole question. The outcome of this was the publication of detailed instructions for carrying out the principal determinations involved.[1] With a view to an extension of their use these methods were brought to the notice of the British Engineering Standards Association in order that this body might consider the adoption of some or all of them as standard methods for the analysis of coal. As a result a widely representative committee was appointed to deal with the matter, and sub-committees and panels are now actively engaged in an endeavour to formulate methods which can be widely adopted for the analysis of coal for commercial purposes.

Careful analysis by such methods will, however, give results of little or no value unless the sample tested is truly representative of the bulk from which it is taken. The question of sampling is even more difficult than that of analysis. The larger the sample, up to a point, the more likely is it to be truly representative of the consignment, but the cost may then become prohibitive. A compromise has therefore to be reached in which the accuracy of the sample is sufficiently good for commercial purposes without the expense incurred in obtaining it being too great. Methods of sampling have been considered by a committee of the Fuel Research Board, and a large number of special tests have been carried out, not only at H.M. Fuel Research Station, but also at actual ports of shipment, with reference to sampling from stationary bulks, hoppers, railway waggons and ships, and during delivery from chutes, conveyors, etc. These tests included experiments in regard to the size of the increments, the size of the gross sample in relation to the quantity represented, and the crushing and reduction of the gross sample to a size suitable for the laboratory. Much data has also been received from outside parties interested

[1] Methods of Analysis of Coal. *Fuel Research Board, Physical and Chemical Survey of the National Coal Resources*, No. 7, H.M. Stationery Office (1927).

in the question. Much further information is necessary, however, before final methods for the sampling of coal under different circumstances can be formulated. In the meantime the question is being considered, as in the case of coal analysis, by the British Engineering Standards Association, all the relevant data collected by the Fuel Research Board having been placed at their disposal.

The aid of the microscope has also been enlisted in the examination of coal, the aims being to determine the botanical nature of the original material and the nature of the physical and chemical changes which accompanied its transformation into coal, and to correlate this information with the properties of the surviving material. This was rendered possible by the beautiful technique developed by Lomax, who was one of the first to succeed in preparing sections of coal sufficiently thin to be examined with ease by transmitted light. The important question of the identification and correlation of coal seams is also being investigated by the application of microscopical methods.

Thiessen,[2] in America, applied microscopic methods to coal when, in attempting to discover the cause of the differences between caking and non-caking varieties, an exact knowledge of the origin and composition of coal became necessary. For this work he employed thin (translucent) sections and polished but unetched surfaces. Thiessen recognised three components in ordinary bituminous coals—bright coal, dull coal and the so-called mineral charcoal; the last occurs usually in very thin laminæ, the first two components constituting the bulk of the seams. To the bright and dull coal he gave names indicative of their origin: the bright coal, each lenticle of which he considered to be derived from a single portion of a coal-forming plant or tree, he called anthraxylon; the dull coal, composed of finely-comminuted plant debris a kind of botanical mud—he called attritus. In passing it may be stated that recent evidence appears to show that some bright bands may also be derived from debris.

It is essential for complete knowledge of a coalfield to be able to trace which seam is which over the whole area. Frequently this can be effected by geological means alone, but Thiessen and his collaborators[3] have employed microscopical examination to assist in the correlation of coal seams. They showed that different seams contain different assemblages of spore-exines (the outer coats of the reproductive elements of non-flowering plants), and have succeeded in correlating certain seams by the recognition in them of characteristic microspores.

[2] Thiessen, R., Structure in Palæozoic Bituminous Coals, *U.S. Bureau of Mines Bulletin* 117, 1920.

[3] Thiessen, R., and Voorhees, A. W. A Microscopic Study of the Freeport Bed, Pennsylvania, *Carnegie Institute of Technology, Bulletin* 2, 1922.

Thiessen, R., and Staud, J. N. Correlation of the coal beds in the Monogahela Formation in Ohio, Pennsylvania, and West Virginia, *Carnegie Institute of Technology, Bulletin* 9, 1923.

Thiessen, R., and Wilson, F.E. Correlation of coal beds of the Alleghany Formation of Western Pennsylvania and Eastern Ohio, *Carnegie Institute of Technology, Bulletin* 10, 1924.

The significance of spores for correlation purposes has been studied in Europe by Lomax, Lange, etc.,[4] and by members of the South Yorkshire Fuel Research Staff of the Department of Scientific and Industrial Research.[5] The latter have also investigated the distribution of spores in certain Yorkshire seams. By means of thin sections representing the seam from floor to roof the megaspores have been classified, and the number of each type in the different sections has been recorded. The results so far obtained indicate that, even when no single distinctive megaspore characterises a seam, the relative concentrations at different horizons may be utilised for correlation purposes.

The constitution of coal has been the subject of a considerable amount of microscopical work. Stopes,[6] in a paper published in 1919, rendered the distinctions between bright and dull coal more definite by the introduction of four terms based upon the physical characters of the banded constituents These terms vitrain and clarain for two types of bright coal, and durain and fusain for two types of dull coal—have been widely adopted in Europe, though not without some uncertainty as to their meaning, due to attempts at correlation with terms based upon botanical considerations, such as the anthraxylon and attritus of Thiessen previously mentioned. Stopes' definitions were based primarily upon macroscopic features, and although she gave an indication of the microscopic characters of the constituents the establishment of these must be the task of later investigators.

C. A. Seyler, of Swansea, has made a notable contribution to this aspect of the work in developing the technique of the metallographic method first applied to coal by Winter. Specimens are ground flat, polished and etched, and examined under the microscope by reflected light. By this method Seyler has shown that plant structures in coal are more numerous than was previously supposed, and that vitrain —originally considered by Stopes to be structureless—may contain traces of plant remains. Moreover, lenticles of both vitrain and clarain—the bright constituents of coal, together corresponding to Thiessen's anthraxylon—are not necessarily derived from single plant fragments, as Thiessen asserts, but may originate from plant débris. Seyler has also shown that, sometimes in a single plant fragment, well-defined structures may pass by various stages into a nebulous state, becoming obscured and finally lost.

A further advantage of this method of examination is that, in order to determine the true nature of plant remains, specimens can be examined in three planes at right angles by preparing three surfaces in those directions. By this means it is possible in some cases to assign a fragment to the particular

[4] Lange Th., Die Bedeutung der Sporen für die Stratigraphie des Karbons, *Zeit Oberschles Berg. u. Huttenmänn. Ver.*, 1927, 66, 340.

[5] Evans, M. M., Correlation of the Parkgate Seam: a Preliminary Study, *Trans Inst. Min. Eng.*, 1926, 71, 451

[6] Stopes, M. C., On the Four Visible Ingredients in Banded Bituminous Coals Studies in the Composition of Coal, No. 1. *Proc. Roy. Soc.*, 1919 (B), 90, 470.

genus, or even species, to which it belongs[7] and it would thus appear that the method may perhaps be applicable to the correlation of seams.

Kellett,[8] working under the direction of Professor G. Hickling of Armstrong College, employs the microscope to trace the vertical and lateral variations in the ash contents of certain coal seams of Durham and Northumberland. By means of series of thin sections cut from pillar samples representing the entire thickness of the seams, and by chemical analysis, he has recorded the variations in the percentage and nature of the ash. The preliminary investigations have shown that the distribution of the ash and of the banded constituents may be characteristic of a seam, and attention has been turned to correlation by this method.

The application of X-rays to the examination of coal, the first recorded example of which occurred as long ago as 1897, has in recent years been taken up by many workers, in this country, notably by C. N. Kemp.[9] This line of investigation is concerned with the study of the ash in coal and depends upon the differences in transparency to X-rays of the organic coal substance and the inorganic ash constituents, the latter, being relatively non transparent, are seen in marked contrast in the resulting radiograph. From the results so far obtained it seems probable that, with improved technique, the method should provide a rapid means of determining the distribution, nature and amount of the ash in coal; while, with the aid of stereo-radiographs, it should be possible to study in detail the structural characteristics of the ash.

Much of the work described was assisted by grants from the Department of Scientific and Industrial Research.

The foregoing illustrates some of the more important scientific methods which have been adopted in recent years to give a closer knowledge of the coal substance. The necessity for such information increases with the complexity of the process to which it is intended to subject the coal, but when it is to be burned in its raw state many of the details referred to are not of primary importance. In this case the calorific value must be known, since it is a measure of the maximum energy obtainable; also the ash content and the fusibility of the ash, since these determine the amount of inert material and the precautions which must be taken to deal with the slag. The moisture content of a coal is of obvious significance, and some knowledge of its caking properties is needed since these determine its behaviour in various types of grates. The volatile matter also affects the design of furnaces for smokeless combustion and efficiency, and limits to some extent the applications feasible. All these factors can be determined by relatively simple methods.

[7] Seyler, C. A., On the Dictyoxylon Cortex of Lycopodiales as a Constituent of Coal *Phil. Trans* B., 216, 353.

[8] Kellett, J. G., The Physical Constitution of Bituminous Coal and Coal-seams, *Trans. Inst. Min. Eng.*, 1928, 75, 400; and The Distribution of Ash in Bituminous Coal-seams. *Trans. Inst. Min. Eng.*, 1928, 75, 413.

[9] Kemp, C. N., The X-Ray Examination of Coal Sections, *Proc. Roy. Soc. Edin.*, 1928, 48, 167.

Coal is a highly complex organic substance made up mainly of the elements carbon, hydrogen, sulphur, oxygen and nitrogen; and coal and its derivatives are of great importance in the chemical industries, since they provide the raw material for the manufacture of a wide range of commodities, indispensable to modern civilised life, such as dyes, drugs, disinfectants, fertilisers, etc. Nevertheless, an overwhelming proportion of the world's vast output of coal is used mainly by virtue of its energy content, for the production of heat, power and light. It is thus essential that as large a proportion as possible of the heat units in this coal should be released and subsequently utilised for the required purposes, and the most direct measure of the value of appliances for heat production is the "efficiency ratio" of heat utilised to potential heat in the coal burned.

Although of considerable significance, such thermal efficiency figures do not always run in line with true commercial efficiency, which is controlled by a variety of factors other than the mere proportion of heat utilised in a process, and must take into account a complete range of operations. It is concerned not only with thermal energy, but also with the materials, labour and appliances necessary to clear a site, erect and equip a factory with the requisite heat-producing and other apparatus (capital costs), and to carry out the manufacturing processes involved (running costs). Rates and transport charges must also be taken into account.

If the generation of a maximum quantity of heat, without regard to its form or application, were the sole aim, the best method of utilising coal would in most cases be to burn it directly in its raw state, since in this way it is possible to liberate a higher proportion of its constituent heat energy than can be obtained through any system of pretreatment. But because it allows of a more efficacious application of the heat produced, or because it influences favourably some extraneous factor, pretreatment may none the less in a large number of cases be advantageous.

In the earlier methods of heat and power production coal was always fired by hand. With careful and intelligent stoking surprisingly good results can be achieved by this primitive method, but in addition to introducing a troublesome element of human unreliability, hand-firing suffers from inherent losses and disadvantages consequent upon its intermittent nature. Thus during the stoking periods the increased access of air causes a cooling down of the furnace which not only results in smoke production, increased flue losses and decreased efficiency, but also makes uniformity of working impossible of attainment. By rendering the process of firing mechanical, much has been done to improve the efficiency of boiler firing units.

The chief problem in burning coal is to bring the fuel into intimate contact with a sufficient quantity of air for its complete oxidation. In practice the difficulty is illustrated by the necessity for supplying a quantity of air in excess of that theoretically required for complete combustion, which yet is

not able to prevent completely smoke production and the escape of potentially useful unburned products up the chimney.

In gaseous fuels, since each particle of combustible matter is in the molecular state, it is comparatively simple to secure such intimate mixing as will allow of every molecule being brought rapidly into contact with the oxygen necessary for its combustion. Liquid fuels similarly, by vaporisation prior to combustion, can be given free access to air, but since the molecules of a liquid are much more complex than those of a gas, the process of burning is less direct. The primary considerations in oil burning appliances are thus the evaporation of the oil and its subsequent contact with sufficient oxygen. With the heavier oils mechanical "atomisation" is necessary in order that vaporisation may proceed rapidly and efficiently.

In solid fuels, the aggregations of molecules are enormously larger than those of liquid or gaseous fuels. When one imagines a piece of coal lying on a furnace bed with only its surface molecules exposed to air, and with the air supply contaminated by inert gases, it is indeed a matter of some surprise that such high efficiencies can be obtained in practice.

Consider the principal combustibles, carbon and hydrogen. These can exist either separately, or in enormous numbers of different combinations, either gaseous, liquid or solid, at atmospheric temperatures and pressures. Some of these, although liquid or solid at atmospheric temperature, can be gasified under an increased temperature, but we may have aggregations of solid molecules which cannot be gasified by the action of heat alone to molecules of the same composition. Coal falls into the latter class.

It is only in the simplest compounds, such, say, as carbon monoxide and hydrogen, that it is possible to imagine that by thorough mixing each molecule can be brought adjacent to the necessary molecule of oxygen for its complete combustion, so that they may combine immediately the temperature of the mass is raised to such a degree that chemical combination at an appreciable rate is possible. Given such an intimate mixture of simple molecules it is possible to imagine combustion taking place without any further circulation of the molecules being necessary. The ease of burning, with high flame temperature, of water gas, which consists of approximately equal parts by volume of carbon monoxide and hydrogen, is due to this. As soon as the molecule becomes more complex, such as methane or ethane, it is no longer possible for all the atoms composing it to be so favourably placed in relation to the oxygen molecules that they can immediately pick up the oxygen necessary for combustion, but relative motion must take place between the molecules of the combustible gas and the oxygen, so that the atoms forming the methane molecule may make contact with the four atoms of oxygen necessary to attain complete combustion. Although relative motion is necessary, in such an example as that quoted the degree of so-called turbulence required to effect rapid combustion need not be very great. But as the mole-

cule increase in complexity we see that in addition [illegible] mixed initially, relative motion of constantly increasing amount [illegible] between combustible molecules and oxygen molecules, to ensure rapid com[illegible] bustion and the attainment of maximum flame temperature. Further, in the more complex molecules Professor Bone has shown that combustion proceeds by a series of successive reactions between the atoms of the molecules themselves and the oxygen atoms within reach with the formation of intermediate compounds before the final oxidation to carbon monoxide and water.[10] If at any stage in the reaction the partially split molecule finds itself out of reach of the necessary oxygen, hydrocarbons or carbon may be formed which are more difficult to burn quickly and tend to increase of soot formation. If we imagine a single molecule to be surrounded by the necessary number of molecules to burn it, the latter will obviously occupy a larger and larger space as the combustible molecule becomes more complex, so that the more complex the molecule the longer the relative path which it must move through before it can have picked up all the oxygen for complete combustion.

When we come to the burning of solid particles of even the smallest size that can be produced by pulverisation, each aggregation of molecules is so concentrated that even when each particle of combustible is at the centre of a sphere containing all the necessary oxygen molecules for complete combustion, this sphere will at atmospheric temperature be about 23 times the diameter of the particle or [illegible] times its volume. At 2,500° F. these figures become diameter [illegible] times, volume [illegible] times, and the relative travel of combustible to oxygen will necessarily be vastly greater than that necessary in the case of the simple mixture of two gases, however complex the molecule of the combustible gas may be. We therefore get from the burning of, say, carbon monoxide to the burning of a [illegible]-mesh particle of carbon a complete inversion of the relative importance of intimate mixing as such and relative velocities of the molecules. In the former case intimate mixing is of paramount importance, in the latter relative velocity is everything. A lump of carbon lying on the grate of a boiler may eventually be completely consumed by a large volume of air by bringing oxygen molecules in succession into contact with the surface of the coal. When gases are evolved mixing of course takes place, but intense combustion so as to obtain maximum temperature can only be accomplished by a rapid velocity of air along the surface of the coal.

These considerations, elementary as they are, explain the developments which have taken and are taking place in the manner of burning powdered coal and afford a reason for the success of the so-called turbulent burner. Turbulence as such is, however, an uncontrolled way of attaining relative motion between coal and air particles and involves a breaking up of stream lines. What is needed is to obtain as stable and streamline a form of motion of the air as is

[10] Bone, W. A., "Coal and its Scientific Uses," Chapter X. (*Longmans*, 1918.)

possible, and induce the particles of combustible to move from one stream-line to another in as controlled a manner as possible. During recent years burners and furnaces (for the latter are of equal importance with the former), have gradually tended towards getting a better control of this relative motion, but mathematical analysis of the problem shows that much more is possible and that the limit to the amount of heat release which can be obtained in a furnace of given volume is only governed by the impossibility of obtaining furnace materials which will stand the drastic action to which they may be subjected. Recent years have seen reductions in combustion volumes, and the application of powdered fuel to the furnaces of Scotch boilers which a few years ago was considered impossible. An extreme case of limitation of furnace volume occurs in the locomotive, but although some success for pulverised fuel is claimed even in this field, the small volume of the furnaces still presents great difficulties. The writer is confident, however, that eventually it will be possible to utilise powdered coal in locomotives with high efficiency; but this will not occur until the design of both furnace and burner is such as to incorporate the principle of a controlled motion of the particles relative to or across the stream lines of the gas, with the abandonment of the idea that uncontrollable turbulence is all that is required.

Since the simple molecules carbon monoxide and hydrogen can be induced to burn rapidly by mere intimate mixing, the problem of burning materials of great molecular aggregation would probably be simplified if the portion of the consuming appliance dealing with the solid particles could be reduced to a minimum, since this portion of the apparatus is the one where high relative velocities between particle and air are needed to get high stream-line interchanges. As soon as the particles have been reduced to the gaseous form, whether by physical changes alone in liquid fuel, or by chemical changes in solid fuel, the high velocity factor becomes less important and mainly induces rapid mixing. It would thus appear that the function of that portion of the apparatus dealing with the solid material could best be reduced to the delivery as end product of producer gas. The remainder of the furnace would not then require the refinements of design necessary to ensure the maximum degree of stream-line interchange. Also the temperature involved in the burning of carbon to carbon monoxide is considerably less than that involved in burning of carbon to carbon dioxide; and on account of the smaller heat release the provision of refractory material, or the cooling of metallic walls, becomes of much less importance. The temperature might possibly be reduced to such a degree as not to fuse the ash.

The combustion of solid material must always suffer from the disability that, unlike even the heaviest oil particle, coal cannot be immediately vapourised; but it can, nevertheless, be brought by pulverisation into a state in which the surface exposed to the action of air is enormously increased over that of the lump, or even of the slack, form although, even with the finest pulverisation

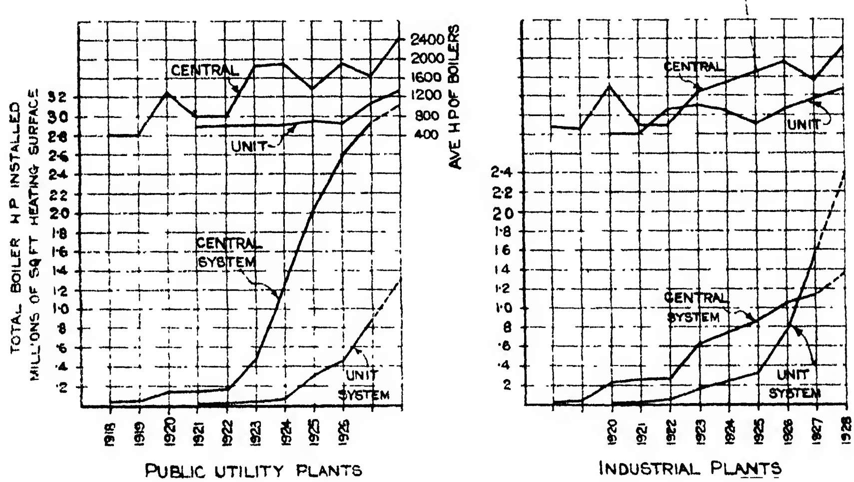
attainable, the particles still remain large compared with chemical molecules. For instance, by grinding a piece of coal 1 inch cube so finely that it will just pass through a sieve containing 300 meshes to the inch, the total exposed surface of the resulting particles is increased to 300 times that of the original single lump of coal; but the relation which the mass of each of these particles bears to the mass of a molecule, say of methane, is still about the same as the mass of a lump of coal the size of the earth would bear to a lump of about 25 yards.

Pulverisation alone, however, as we have already seen, does not afford the key to complete combustion; a lump coal, for instance, will burn more easily than a slack, a slack coal more easily than a bed of dust. It is necessary, having obtained through pulverisation the maximum feasible increase in surface area, to ensure the contact of the exposed area with oxygen. The first stage in the process is usually to bring a cloud of the finely-divided particles into suspension in air. When the ratio of combustible matter to air is properly proportioned—between fairly wide limits—such clouds become highly inflammable, and indeed have been the cause of some of the most disastrous colliery explosions on record. The above considerations are so obvious that it is not surprising to find that Niepce experimented with pulverised fuel more than ten years prior to the advent of the first mechanical stoker. (Wm. Bruton, 1819.)

From hand firing to mechanical stoking, however, was a comparatively simple step; the conditions consistent with success in hand-firing were fairly well known, even at that early date, and the problem presented was one only of the application of known principles. All that was necessary was to ensure that in the substitution of mechanical firing devices the necessary provisions for satisfactory combustion should be retained. A very different state of affairs prevailed in regard to the utilisation of coal in the powdered form, extended research work having to be undertaken before its commercial development became at all feasible.

Space would not allow of a full account of the gradual progress of powdered fuel. During the period already referred to, sporadic attempts were made to apply it in the metallurgical field, especially for the production of iron, as well as for heating brick kilns and for glass manufacture. It may be worth noting, however, that in 1877 the *Engineer* reported the application of pulverised fuel to a Cornish fire-tube boiler, an evaporation of 8.3 lb. water per lb. of coal being claimed. This boiler appears to have worked for some time, but was eventually shut down owing to the high cost of pulverisation, and probably also from lack of knowledge of proper furnace design for pulverised fuel. The many problems involved in the burning of pulverised fuel in a minimum volume cannot yet be said to have been completely solved, but progress has been so rapid that it has already found most interesting applications to tank boilers, such as Lancashire or Scotch marine boilers.

Since pulverised fuel lends itself to the production in simple appliances of long flames, it is perhaps natural to find its first commercial success in rotary kilns for cement burning. It was first experimented with for such purposes about 1895 and has now largely superseded other forms of fuel. The particular requirements of this industry are such that full advantage can be taken of the best features of firing with pulverised fuel, while its more doubtful points are of little significance. Long flames can be fully utilised without being subjected to any considerable cooling effects. The lining of the kiln may suffer from the action of the ash, but the disposal of the ash causes no difficulty, since its presence in the final products can be allowed for by adjustment of the relative quantities of the raw materials.



USE OF PULVERIZED FUEL IN AMERICA.

FIG. 1.

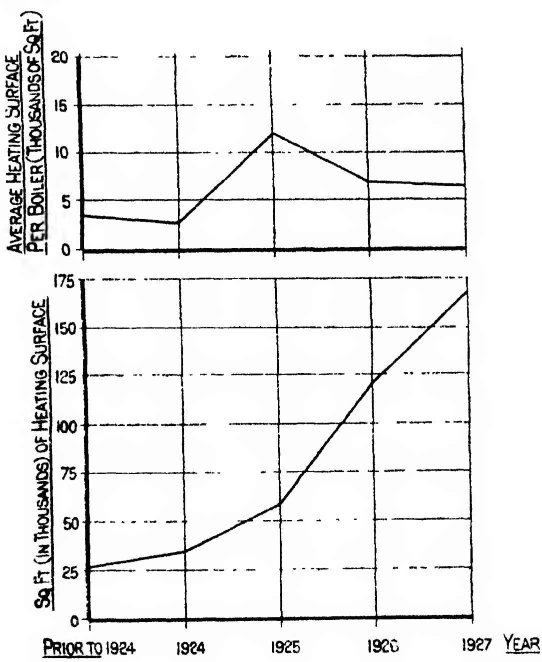
The earliest successful application of powdered coal to boilers is usually credited to Bettington, who, as the result of experience with powdered fuel cement plants, designed an upwardly fired vertical boiler with a burner at the bottom of the firebox and water-cooled furnace walls. Troubles were experienced through slag formation and the slagging up of the vertical burner nozzles, but some of Bettington's installations are still in operation.

So long as pulverised fuel was applied only to furnaces such as cement kilns where the long flame could be injected coaxially with the furnace, and where large furnace volumes with comparatively low values of heat release per unit volume were sufficient, the problem remained comparatively simple; and, generally speaking, success is much easier of attainment where large combustion chambers can be provided, as in many types of water-tube boiler, than in appliances where more restricted conditions obtain. Much progress has been accomplished during the past decade, and, particularly in America,

there has been a rapid development of pulverised fuel firing in large water tube boilers for central electricity generating stations and similar installations.

With pulverised fuel complete combustion can be ensured with relatively low air supply, and high working efficiencies can be maintained. Flexibility is a further advantage of pulverised fuel installations; fires can be started at very short notice, and response to changing load requirements is rapid Further, the plant can be operated successfully on a wide range of coals.

Fig. 1, which has been adapted from a Report of the Pulverised Fuel Sub-Committee of the U.S National Electric Light Association (1928) shows the total heating surface in millions of square feet served by unit systems and central storage systems installed in public utility plants and industrial plants



THE USE OF PULVERIZED FUEL IN ENGLAND

FIG. 2.

in the U.S.A. at the end of each of the past ten years. The curves show a rapid increase not only in the total boiler horse-power installed, but also in the average horse-power of pulverised fuel boilers. The increasing popularity of the unit system of firing is evident, particularly in the case of industrial plants.

Data given by Rosencrants[11] and illustrated in Fig. 2 show a simultaneous

[11] Sosencrants, F. H., "Pulverised Fuel Firing," *World Power Conference, Fuel Conference* 1928, *Section M.*

increase in pulverised fuel systems in England; but in 1927, the latest year for which comparisons are available, while the total boiler horse-power installed in public utility and industrial plant in the United States amounted to 6½ million square feet of heating surface, in England it had reached only 2 or 3 per cent. of this figure.

The centralised system, in which coal is first dried and then ground in a centralised plant from which it is delivered by piping or other suitable arrangement to all the boilers of the station entirely held the field until about 1923. About this time there were introduced both in Great Britain and America, small self-contained pulverisers, each designed to feed its products directly to its own separate boiler. Prior to the advent of the unit pulveriser it was not usually economical to adopt pulverised fuel firing on other than a very large scale, and even at the present time by far the greater proportion of pulverised fuel is consumed in a relatively small number of very large installations, most of which utilise the central system.

So far as Great Britain is concerned, the practical application of pulverised fuel is still in its infancy, but in America over 25 million tons of coal were consumed in this form during 1928. This was distributed roughly as follows:

Boilers	... ...	11 million tons
Cement	.. ..	6 ,, ,,
Metallurgical furnaces	... ..	3 ,, ,,
Copper smelting	.. ..	2 ,, ,,
Miscellaneous	... .	3 ,, ,,
Total	..	25 ,, ,,

The total amount of this pulverised coal was about equally divided between direct and storage systems, although in point of number the unit installations particularly in industrial plant, greatly exceeded the central installations, showing that the former system is applicable mainly to small scale plant. For boilers of really large size the central system still holds the field, but the unit system, which although probably slightly less efficient than the central system is lower in capital cost, appears also to be obtaining a footing. Whether or not its development for large scale work will continue, it is impossible to forecast, since efforts are being made to reduce the capital cost of the centralised system by careful design and by such means as the elimination of coal dryers, etc. It is probable also that the apparent overtaking of the centralised system by the unit system is due in some degree to the fact that at the moment unit systems are fashionable, and many unsuitable applications, which may tend later to cause a set back, have been made. Unit mills have been used with boilers as small as 16 feet by 5½ feet, or about 100 h.p. nominal rating, efficiencies of 74% to 75% having been reached. For metallurgical and copper work central systems are employed almost exclusively. In large scale powdered

coal installations very high efficiencies of steam raising, say 80% to 90%, can be maintained. It is also claimed that owing to the general application of water or steam cooling of the combustion chambers of pulverised fuel plant, maintenance costs, especially repairs to furnace refractories, are relatively low, while stoppages due to breakdown are minimised. On the other hand it must be remembered that modern practice has made possible almost equally high efficiencies in stoker-fired boilers.

When a relatively new development is advocated, and adopted as an alternative to established practice, it often happens that incidental improvements of design, equally applicable to the other methods, can be incorporated in the new plant, giving it an apparent overall advantage to which it is not altogether entitled. On the other hand, costly but advantageous elements of design in the new plant, which would be equally necessary in older designs if maximum efficiency were looked for, may unfairly be accounted drawbacks.

Among the former may be cited the adoption of water-cooled walls where high rates of burning pulverised fuel are necessary. For similar performances such cooling is equally necessary with mechanical stokers, but has developed far more rapidly in connection with pulverised firing as a means of obviating the enormous furnace volumes which have hitherto been required to avoid the destructive effect of the impinging of flames, or of intense radiation on the furnace walls.

The large combustion volumes apparently needed for burning pulverised fuel have in the past tended to react against it, and the figure of 25,000 to 30,000 B.Th.U. per cubic foot per hour of heat release adopted by designers of pulverised fuel furnaces, were compared with the 80,000 to 100,000 B.Th.U. of the mechanical stoker furnace. This latter figure had, however, been adopted as a compromise between the enormously increased capital cost associated with furnace volume increase in a stoker fired installation and the saving due to more efficient combustion. Actually theory would indicate that the pulverised fuel furnace for equal consumptions really requires volumes less than those required for stoker firing. Much experimental work has been carried out to find the conditions necessary for combustion in the minimum volume. Audibert, in France, burned pulverised coal in a tube furnace with various velocities of air up to those where an undulating motion corresponding to the properties of the tube were attained. When this vibration was attained a rapid increase in speed of combustion was observed, and the flame shortened to half its previous length.

Several years ago some experiments were carried out at the Fuel Research Station on burning coal in the simple circular furnace shown in Fig. 3. As a furnace the experiments were not entirely successful but the results showed quite clearly that coal could be burned in spaces much less than had been considered necessary up to that time. The figures given in Table II show some of the preliminary results obtained during a test designed to gasify the fuel

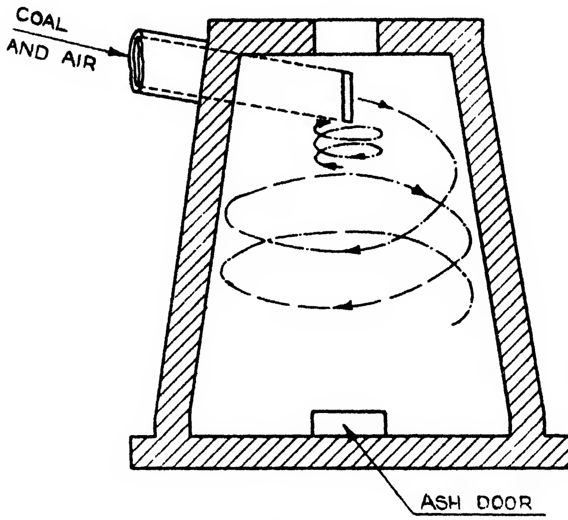


FIG. 3
Experimental Pulverised Fuel Combustion Chamber
at Fuel Research Station

only. The heat release amounted to 90,000 B.Th.U. per cu. ft as against the designing figure of say 27,000 B.Th U.

TABLE II

TYPICAL FIGURES OBTAINED IN EXPERIMENTAL PULVERISED FUEL COMBUSTION CHAMBER

Volume of chamber	20 cu ft.
Feed of coal	420 lb./hr
B.Th U. in coal	4,100,000 B.Th.U./hr
B.Th.U in solid fuel projected from chamber with gas	700,000 B.Th.U./hr
Heat liberated in chamber	1,810,000 B.Th.U./hr
Potential heat leaving chamber in producer gas (c.v multiplied by volume)	1,800,000 B.Th.U./hr
Heat liberated in chamber per cubic foot per hour 1,810,000	90,500 B.Th.U.
Temperature of combustion chamber walls	1220 C
Percentage of ash in coal	25 per cent.
Percentage of total ash deposited in chamber	30 per cent.
Velocity of coal and air stream entering chamber	110 ft./sec.
Inclination of stream at entry to horizontal	15

Probably the highest figures so far reached are those quoted by Brookes in a paper read before the Engineers' Society of Western Pennsylvania in 1925. An attempt was made to simulate the action of the tornado in the furnace illustrated. (Fig. 4.) For details of this work reference should be made to Brookes' paper, but it is interesting to note that the enormous figure of 1,100,000 B.Th.U. per cu. ft. per hour was obtained. By the adoption of a similar principle reductions have been made in the furnace volumes of

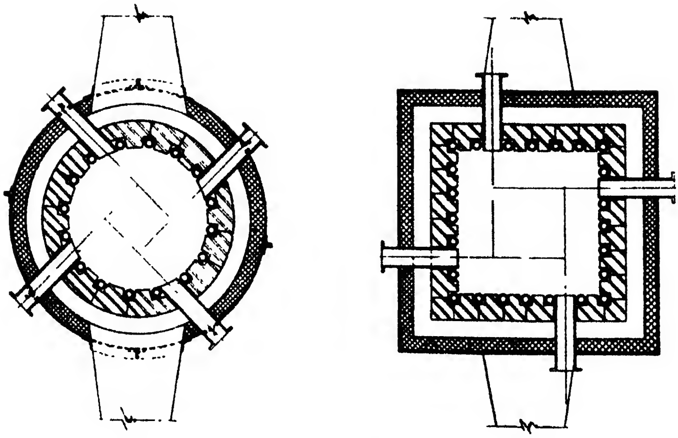


FIG. 4

Experimental Pulverised Fuel Furnace simulating tornado action.

"well" type furnaces, and several installations of a design based upon this experimental work are in operation in the U.S.A. It would not be possible, however, with material available at the present time to approach in practice anything like the figures obtained by Brookes, who considers that 100,000 B.Th.U. is probably the practical limit at present.

A point of difference between stoker fired and pulverised fuel fired furnaces which has always given trouble is ash disposal. When a bed of coal burns on a firegrate the ash tends to settle to the bottom through the bed, and finally to find its way directly into the ashpit without ever having entered the actual combustion chamber. In pulverised fuel firing the ash is injected into the combustion chamber in a finely divided state in association with the coal. So long as pulverised fuel furnaces remained comparatively small in size no great trouble was experienced. The furnace temperature was not usually high enough to fuse the ash which was ejected in fine discrete particles through the smoke stack, but with larger installations this method of ash disposal tended rapidly to become a public nuisance. A boiler installation consuming 1,000 tons of coal per day, for instance, and ejecting half its ash by way of the smoke stack would, if burning a coal of 10% ash content, deliver into the air 50 tons of ash daily. This ash, unless carried away rapidly by winds, would tend to settle upon the surrounding property. Naturally, therefore, many bitter complaints have arisen from residents in the neighbourhood of pulverised fuel plants. The trouble has been partially overcome by the provision of higher chimneys, by cyclone or other dust catchers at the chimney base; or in one or two instances, the Lodge-Cottrell system of electrical ash precipitation has been installed.

In the earlier types of British pulverised fuel furnaces, where air cooled refractory walls only were used, and greater intensities of combustion attained,

molten particles of ash tended to fuse on to the wall and rapid deterioration of the refractory took place. According to Rosencrants, with modern completely water cooled walls the fused particles do not attach themselves very firmly to the walls, so that after a time the weight of the accumulated lumps causes them to loosen and fall down. In some types of furnaces under development in America, the ash is definitely fused to slag and is caused to run down into a slag pit at the bottom, from which it can be extracted from time to time.

In marine application, an important point is to prevent the ash from settling down on the decks. It is understood that trouble was experienced in the earlier voyages of the S.S. Mercer through this cause, but this vessel had unusually low smoke stacks, and the writer is informed that the trouble has now been obviated by lengthening the stacks.

The application of pulverised fuel to marine purposes is exceedingly attractive in a country which has no indigenous supplies of natural oil. The full advantages of oil firing are not likely to be obtained by pulverised fuel but it is very probable that many of them can be realised. The first successful pulverised fuel ocean-going steamer was the above mentioned S.S. Mercer belonging to the U.S. Shipping Board. Troubles of a minor type were experienced during the widely advertised first voyage when the vessel reached Rotterdam in December 1927. The ship is still in commercial service using pulverised fuel and in November 1928 had completed her 6th voyage without having once been behind schedule in spite of minor troubles. At the present time the U.S. Shipping Board are investigating a very attractive form of pulveriser in which, instead of there being one pulverising mill for one, two or even three boilers, a small complete installation of pulveriser, fan and burner is fitted to each furnace of a Scotch boiler. The author had the privilege of seeing this test installation at the Philadelphia Test Navy Yard in November last, and was impressed with the simplicity of the apparatus and the excellent results which were being obtained. It is understood that the Shipping Board are at the present time fitting a vessel which will be fired entirely with this type of equipment.

In Great Britain, useful work is going on in several directions, the voyage of S.S. Stuartstar with unit equipment of the Woodeson type being especially interesting. A new ship, the Berwindmore, is being equipped to burn pulverised fuel and half the boilers of the New Zealand Shipping Company's vessel Hororata are being tried with the Howden Buell system.

In some of the earlier experimental work carried out during the War, auxiliary combustion chambers were built outside the boiler. The present method, which is likely to render pulverised fuel for marine use commercially practicable, is entirely due to the development of burners in which by the induction of so-called turbulence the long flames previously associated with pulverised fuel combustion have been considerably shortened.

The above considerations illustrate the fact that when heat only, as distinct from power, is required, provided that the application is one where comparatively low temperatures are aimed at, as for instance in the production of steam, probably the most efficient method of utilising coal is in its raw state. But there are many industrial operations such as metal working and various chemical processes, which demand far higher temperatures. Furnaces designed for these purposes necessarily have much poorer efficiencies than steam boilers, since the combustion gases are inoperative for the purpose in hand as soon as their temperature has been reduced to the temperature at which the operations are being carried out. The higher the furnace temperature the greater the relative heat loss by sensible heat in the flue gases, and therefore the poorer the efficiency. In such cases, of course, the working efficiencies may usually be considerably improved by recourse to recuperation or regeneration; or, when there is a ready demand for the steam produced, by waste heat boilers. A further loss may occur through incomplete combustion of the furnace gases, and may be partially unavoidable on account of the necessity for a reducing atmosphere inside the furnace chamber.

In all furnaces operating at high temperatures effective control of combustion conditions and efficient recovery of flue gas heat therefore play a vital part in the attainment of good results, and on this account gaseous or liquid fuels offer many advantages over raw coal. Electric furnaces, not being dependent on hot combustion gases for their operation, are no less efficient at high than low temperatures except through increased "radiation" losses. In such cases the higher working efficiencies and greater convenience may more than compensate for the extra initial cost of the potential heat units, although if the electricity is generated from coal the maximum overall thermal efficiency coal-heat power electricity-heat yet possible is only about 20%, mainly on account of the low efficiency of conversion in the step heat to mechanical power.

Where, however, mechanical power is required as such, there is little difference between the overall thermal efficiencies of the various methods of supply, since at one stage or another the low efficiency transformation of heat into power is inevitable. For instance, although electricity is produced from coal at only about 20% efficiency, the subsequent conversion of electricity to mechanical power can in large units be effected with little further loss; whereas although heat can be produced from coal at very high efficiency, the subsequent conversion of heat to mechanical power is a low efficiency one, say 25 to 30%.

The domestic field offers a somewhat difficult problem in efficient fuel utilisation since, generally speaking, a diversity of heat requirements, small individually, but substantial in the aggregate, have to be provided for separately in every household. Raw coal is still the fuel mainly used, although its substitution by gas, coke and electricity is gradually taking place. The annual consumption in this country is about 40 million tons, or over 20% of the total

quantity mined. This on the whole is burned very extravagantly and produces relatively large quantities of tarry smoke. The unsatisfactory results obtained are to be attributed in part to the facts that a single fire is usually relied upon to perform several separate services, that small appliances are inherently inefficient, that with solid fuel it is usually necessary to maintain continuously the fires of plant needed only intermittently, and that the average housewife is totally ignorant of the principles of combustion and heat transfer.

As a rule, gas and electricity appliances are far more efficient than their solid fuel counterparts, but the advantage is not always sufficient to overcome the higher initial cost of the heat units. Gas, however, is becoming general for cooking and intermittent heating purposes, for both of which it can usually compete favourably with raw coal in point of cost. But the extent to which raw coal still holds the domestic field is evidenced by the persistence of so enormous a demand for it. The rational solution of the problem appears to be the provision of a smokeless fuel at a competitive price. It is partly for this reason that so lively and widespread an interest has been shown in the possibilities of the production, by low temperature carbonisation or other methods, of improved forms of coke.

NOTES ON BOOKS

ART IN SCHOOLS. By J. Littlejohns. University of London Press. 10s. 6d.

Both the body of this book and the introduction, by Mr. R. R. Tomlinson, show unusual humour and humanity. It is a happy fact that the "little boys should be seen but not heard" attitude in education is rapidly diminishing; not in "cranky" schools only, but also in schools under the Government little boys are being invited to express themselves. The debt we owe to modern psychology is immense, for this new science helps us to prevent as well as to heal damage to the spirit and the character. The prophylactic measures advocated consist largely in encouragement for the young to express themselves through the medium of some art or craft.

Already in their first two or three years, in what Mr. Tomlinson calls "the stage of Manipulation," children gain by being allowed to use a pencil. We are not surprised to find that the next two stages, those of Symbolism and Realism, come in the same order as the corresponding stages in the history of art; as naturally they are followed by the stage of "Awakening," when the children wish to express their own personality with greater emphasis.

In the past, teachers neither knew these broad facts nor were in a position to learn them and act upon the experience acquired. But progress has been made, and by an interesting circuitous route even taste is a little coming into its own. It is recognised that a teacher without sensibility will be unable, first, to establish the necessary contact with children whose individual propensities it is intended to foster, and, secondly, direct their attention to suitable models.

This book, which is to be highly recommended, contains a number of excellent hints for teachers on how to stimulate the powers of observation; these hints suggest types of expedients which can always be varied according to the circumstances and location of a school.

P.B.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

THE QUEEN AT THE SOCIETY'S EXHIBITION OF DESIGNS.

H.M. the Queen, accompanied by the Hon. Margaret Bigge and the Hon. Gerald Chichester, paid a visit on Friday, August 9th, to the Royal Society of Arts Exhibition of Industrial Designs which is being held during this month in the Exhibition Pavilion of the Imperial Institute, South Kensington. Her Majesty was received by Mr. Llewelyn B. Atkinson, M.I.E.E., Chairman of the Council of the Royal Society of Arts, Lieut.-Gen Sir William Furse, K.C.B., D.S.O, Director of the Imperial Institute, and Mr W. Perry, the Assistant Secretary of the Society.

Her Majesty inspected all the work shown, expressed much interest in the Exhibition and was graciously pleased to purchase one or two pieces of pottery.

The Exhibition will be open free of charge, no tickets being required, until September 1st, every week-day from 10 a.m to 5 p m and on Sundays from 2 30 to 6 p.m.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE TREATMENT OF COAL.

By C. H. LANDER, C.B.E., M.Inst.C.E., M.I.Mech.E , F.Inst.P., Director of Fuel Research, Department of Scientific and Industrial Research.

LECTURE II.

(*Delivered January 28th*, 1929.)

In the first lecture, after touching on some of the newer methods of investigating the constitution of coal seams, it was pointed out that in dealing with the scientific aspects of burning coal in the raw state, the simpler forms of

physical and chemical investigation give adequate information. Where processes of carbonisation or hydrogenation of coal have to be considered, however, a more exhaustive and intimate knowledge of the coal substance is desirable. The subject has been studied for many years in some detail, but it is only comparatively recently that the work of different experimenters has tended to converge and produce results of tangible importance. It would be impossible in a series of lectures such as these to deal adequately with the immense mass of work which has been carried out. Sufficient for the present purpose will be to mention one or two of the more recent outstanding researches.

In a long series of investigations on the extraction of coal by various organic solvents, Bone[12] has interpreted his researches as showing that a group of nitrogenous "humic" bodies, varying in quantity according to the nature of the coal, can be extracted by benzene under pressure, and he considers that these bodies are mainly responsible for the coking propensities of coking coal. He points out that the residues left after the completion of the extraction are non-caking, and he believes the bodies extracted by benzene to be pre-existent in the original coal complex and not derived from it by chemical decomposition.

Cockram and Wheeler[13] have extracted coal with a series of solvents and in this way have separated a number of fractions, to each of which they attribute definite properties. They conclude from their research "that the agglutinating medium during coke formation consists of the resins and hydrocarbons contained in the coal or is yielded by those resins and hydrocarbons during the early stages of heating in the coke oven."

Francis and Wheeler[14] have also developed a new method of studying coal composition which they term "Rational Analysis," and which forms a valuable addition to the usual methods of analysis. A rational analysis of a coal can be given in terms of the proportions of free hydrocarbons and resinous compounds, organised plant entities, and ulmin compounds, together with the reactivity towards oxygen of the ulmin compounds. In rational analysis, the hydrocarbons and resins are grouped together. "These are oil-yielding constituents of high hydrogen content and their presence in the coal in suitable amount affects (but is not wholly responsible for) its coking power." "The spore exines and cuticular tissues, which form the bulk of the morphologically organised plant entities, are of high hydrogen content and are oil-yielding constituents of the coal, the oils consisting mainly of paraffins and unsaturated

[12] Bone, W. A. Researches on the Chemistry of Coal, Part III. The Extraction of Coals by Benzene under Pressure. *Proc. Roy. Soc. A.*, 1924, 105, 608.

[13] Cockram, C. and Wheeler, R. V. Studies in the Composition of Coal. The Resolution of Coal by means of Solvents. *J. Chem. Soc. Lond.*, 1927, IV.

[14] Francis, W., and Wheeler, R. V. The Rational Analysis of Coal. *J. Chem. Soc. Lond.*, 1928, 2967-2979.

hydrocarbons." The ulmins form the major portion of the coal and they vary in composition with the rank of the coal.

Bone and Quarendon[15] found that when the residue resulting from the extraction of coal with benzene under pressure was oxidised by treating it with alkaline potassium permanganate, 20-40% was recovered in the form of acid oxidation products, from which mellitic acid and benzene—1 : 2 : 3 : 4—tetra-carboxylic acid was obtained. From this they conclude "that coal actually contains 6-ring structure." The continuation of this work has been assisted by a grant from the Department of Scientific and Industrial Research.

Some confusion exists regarding the interpretation of the term "decomposition point" of coal. It is clearly necessary to distinguish between products distilled from the coal without change and those resulting from the decomposition, however slight, of organic matter King and Willgress[16] have carried out experiments to ascertain the initial temperature of carbonisation of coal. They have shown that if coal is carefully heated out of contact with free oxygen decomposition takes place with the liberation of visible amounts of liquid oils at temperatures varying from 180°C. for peat, to 215°—245°C. for bituminous coals. With bituminous coals the temperature of initial decomposition appears to increase with increasing oxygen content and decreasing carbon content.

Holroyd and Wheeler[17] have published a paper in which a method for determining the decomposition point of coal is described. "The method of experiment involved the heating of 250 gram charges of finely powdered coals under a high vacuum at different temperatures. Under these conditions the action of heat on the individual ingredients of the coal could be followed comparatively easily. No marked decomposition occurred with any bituminous coal below about 300°C." A considerable number of coals were studied by this method and it was found that the decomposition point ranges from 290-300°C. to 360-365°C. Holroyd and Wheeler state, "We are satisfied that the temperature at which oils first make their appearance when a bituminous coal is heated is not the temperature of initial decomposition of the coal, but that such oils are distilled unchanged. In our experience, the temperature at which such oils first appear bears no relation to the carbon content of the coal. It has, however, a tendency to be lower the greater the proportion of free hydrocarbons in the coal." In view of such conclusions it would appear that some more accurate agreement upon the use of the term "decomposition" as applied to the coal aggregate is necessary.

[15] Bone, W. A., and Quarendon, R. Research on the Chemistry of Coal. Part IV. The Oxidation of the Residue from the Benzene-Pressure-Extraction Process. *Proc. Roy. Soc. A.*, 1926, 110, 537-42.

[16] "The Primary Decomposition of Coal." *Fuel Research Board Technical Paper, No.* 16. H.M. Stationery Office, 1927.

[17] Holroyd, R., and Wheeler, R. V. Studies on the Composition of Coal, Oil Yielding Constituents. *J. Chem. Soc. Lond.*, 1928, p. 2669.

A question of more immediate practical value than the above-mentioned considerations is a method for determining the coking characteristics of different coals. Several types of assay provide the requisite information about the type of coke produced from a given coal and indicate also the comparative yields of tar, gas and liquor. By means of correlation with a considerable number of results from experiments carried out on a large scale in different carbonisation plants it has been shown that assay results can be successfully interpreted in terms of large scale working. Further, the method can not only be used for the characterisation of coal but also for the determination of the most suitable blends of two or more coals for coking purposes.

In dealing with high temperature carbonisation it must be remembered that this process forms the basis of two very large industries at the present time together consuming nearly 40 million tons of coal, namely the gas industry and the coking industry. The technique of these industries is based upon experience extending over something like 100 years. Although suffering from present industrial conditions, both industries have been profitable in the past, are in many parts of the world profitable at present, and will most probably become profitable again in the future. In industries such as these technical advances are not likely to follow some revolutionary change or discovery, but rather to result from the painstaking labours of the men in charge in applying up-to-date knowledge to their own local conditions, so as to produce minor improvements, perhaps individually of the order only of 1 or 2 per cent., but which in the aggregate may reach enormous figures.

In this connection it is of interest to mention one economy which has arisen partly from the work at the Fuel Research Station. In a setting of vertical retorts the whole face was studded with cast iron sight boxes through which what was going on in the combustion chambers could be seen. As a result of some repairs being necessary to the retorts the opportunity was taken of replacing the sight boxes by fireclay plugs. The retorts, of course, had been used and were always used for experimental work. There was accurate knowledge of the amount of heat that was used in the setting, including the amount credited to radiation. After the change, the amount of heat required was reduced by one-sixth, equivalent to a thousand cubic feet of water gas per hour. It is not claimed that this result was solely responsible for what followed, but it certainly bore its part. It is now recognised that the putting in of such boxes resulted in an enormous waste of heat, and the makers of those retorts are now putting in fireclay plugs; in their house journal they said it was the result of the investigations at the Fuel Research Station. The total saving of fuel to the country, multiplied by four-fifths, the amount automatically passed on to the consumer under the Gas Regulation Act, comes to about £45,000 to £50,000 per annum, which is the total cost of the Research Station at East Greenwich.

The aims of the two established high temperature carbonisation industries are distinct. The function of the gas industry is to provide, through centralised sources, gas at the lowest possible cost to the consumer. The function of the coking industry is to produce coke of a type which shall fulfil the requirements of the user, mainly at present the iron and steel manufacturer, so that his overall operations may be profitable. To be able to buy coke as such at the lowest possible price is not necessarily the primary consideration ; the chief desideratum is rather that the character of the coke procured shall be such as to enable the subsequent operations of iron and steel making to be carried out with the greatest overall commercial efficiency.

Dealing first with some of the points of high temperature carbonisation as affecting the gas industry, it is not always recognised by the critics of this industry that the cost of gas into the gasholder is only a fraction of the average cost to the consumer, and indeed that the cheapest gas into the holder is not necessarily the cheapest to the consumer. A gas company is both a wholesaler and a retailer. Its customers consist of practically every household in the area which it supplies, most of these households taking gas in very small quantities, and on this account distribution and management charges must be high. As a result, the price of gas to the consumer is usually about three times the cost into the holder, and it is obvious that the reduction of charges other than those directly associated with actual manufacture may in many cases have an effect on the supply of cheap gas as great as or greater than any to be accomplished through improvement in manufacture. In other words, the cost to the consumer includes, besides the cost of manufacture, the following items:—(1) distribution (2) maintenance of fittings, and (3) management. It is obviously of great importance to adjust the processes of manufacture not merely in such a way as to obtain the lowest price in the retort house, but also bearing in mind the possibility of savings in distribution or other costs.

The main factors of manufacture which have an effect on the distribution costs are as follows : —(*a*) Specific gravity, since this affects the cost of pumping and the total amount of heat that can be got through the mains. (*b*) Calorific value, since the volume of gas which must be delivered to the consumer is roughly inversely proportional to the calorific value. (*c*) Water content, since this also affects deleteriously the cost of distribution. (*d*) Naphthalene, which tends to deposit and choke the pipes, and which, if allowed to accumulate, entails increased pumping costs. (*e*) Carbon di-sulphide, which causes rapid deterioration of fittings. These are only some of the points which have to be taken into account by every gas manager in determining the degree of elaboration which he must face in order that the cost of gas to the consumer may be a minimum.

It is sound policy to introduce more expensive processes for effecting reduction of specific gravity, increase of calorific value, removal of water, freedom from

naphthalene deposits, reduction of organic sulphur compounds, etc., if their additional cost can be more than counterbalanced by consequent reductions in distribution, maintenance or management expenses.

During the past 25 years a quiet revolution has taken place in the gas industry. The greater use of gas for heating purposes, coupled with the replacement of the old bat's-wing burner by the incandescent mantle, has gradually rendered the old illuminating standards obsolete, and at the present time the only requirement of the consumer is heat. The trend of the industry during this period is so well-known as to render any detailed discussion superfluous. It will be remembered, however, that the whole question of illuminating standards and calorific value was brought to a focus in 1919 when the Board of Trade asked the late Sir George Beilby, then Chairman of the Fuel Research Board, and Director of Fuel Research, to examine the question generally and advise as to any changes which ought to be made in the legislation governing the matter.

Much experimental work was carried out at that time both by the industry and by the Fuel Research Board on the bearing of calorific value *per se* upon the consumers' requirements, and it was shown that within certain wide limits the consumer could be as well served by a gas of low calorific value as by one of high calorific value, provided the consuming appliance was designed in such a manner that it could supply, by an increase in the volume, sufficient gas to give the total heat requirements for the particular purpose in view. This result, whilst including such operations as the boiling of water which do not require high temperatures, was somewhat less easy to demonstrate where flame temperature is of importance, as in the heating up of an incandescent mantle. The question of flame temperature, however, and its bearing on incandescent illumination was studied at Leeds by the Gas Investigation Committee of the Institution of Gas Engineers.[18] When gas is burned the theoretical flame temperature depends upon the ratio between the heat developed and the heat capacity of the so-called flue gas, and it was shown that over a wide range of gas mixtures this ratio remains substantially the same and that the theoretical flame temperature attainable is therefore much the same throughout. In other words, equal amounts of light will be got in an incandescent burner from two gases of widely different calorific value, provided the appliance is such that the necessary number of B.Th.U. can be delivered. Actual experiment revealed differences, but these could be accounted for by such factors as size and shape of flame, etc.

It was pointed out by the Fuel Research Board that the fixing of a uniform low standard of calorific value might be as great a danger in the development of the industry as the fixing of a uniform high standard would be, and that the desired elasticity could best be obtained by so safeguarding the interests of the consumer that each gas undertaking might be given freedom of choice

[18] Second and Third Reports of the Gas Investigation Committee of the Institution of Gas Engineers, 1919, 1920.

as regards raw materials, processes of manufacture and quality of gas, so that it might be in a position to meet the needs of the locality most satisfactorily. It was therefore recommended that the consumer should be charged for the thermal units which he actually received in the same way in which the consumer of electricity was charged for the Board of Trade units recorded by his meter,[19], and this recommendation was subsequently incorporated in the Gas Regulation Act (1920), which decreed that gas should be sold by the therm (100,000 B.Th.U.). Under this Act there is a self-declared standard of calorific value to which each gas undertaking must adhere, but which can be changed after due notice. The important duty of adjusting the consumers' fittings to the new calorific value, however, devolves upon the gas companies.

Since the Act of 1920 there has been a general reduction in the price of gas. This is due in part to the gradual reduction in the costs of labour, materials, etc , which has taken place since the war ; but it is fair to claim that a considerable proportion of the reduction is to be attributed to the freedom which has been given by the Act to the gas manager to adapt his operations to his own local conditions, taking into account all the factors which affect cost, both in the retort house and in the distribution system.

Another great change in gas industry practice has also occurred during the past 25 years, namely, the introduction and development of the modern vertical retort, which is now so widely used that roughly 50% of the coal carbonised by the industry is effected in this type of appliance.

The history of vertical retorts is another illustration of the point made at the beginning of this lecture, namely that in an established industry such as gas manufacture, progress depends essentially upon refinements capable individually of effecting only small improvements. That this is so is borne out by the fact that vertical retorts have not completely replaced horizontals. The points of advantage which vertical retorts can fairly claim are the following. More gas is made per square foot of ground space than can be produced from horizontals. Under the confined conditions which must necessarily exist in a large town this point is obviously of the very greatest importance and tends to become more and more so as time goes on. When vertical retorts were first introduced they occupied for the same gas make about one-seventh of the ground space of horizontal retorts ; but with more recent developments in horizontal retorts, such, for instance, as the gradual increase in the practice of high benches, the vertical retort has lost some of this advantage, and now occupies about one-third of the ground space of the horizontal. This is an example of the way in which new appliances put older types on their mettle and tend to the improvement of the whole practice. Another advantage of the vertical retort is that in general the labour cost per therm of gas made is less. The capital cost per therm may also be lower, and again a lower fuel consumption

[19] "The Therm," *Department of Scientific and Industrial Research.* H.M. Stationery Office, 1922.

per therm gives a higher carbon efficiency. The gradual development of waste heat boilers during the past few years has again increased this important ratio. Another point in favour of the vertical retort is that it is easier to produce dry coke without complicated auxiliary appliances.

Such a recital of the merits of verticals necessarily begs the question as to why the horizontal retort still survives at all, but it should be pointed out that vertical retorts work best with nut coal, although they will give satisfaction with any size except fine slacks. On the other hand, they are more susceptible to variations in the type and quality of the coal, and on this account require a higher grade of intelligent control. In gas works of any appreciable size, however, it is usually recognised that the best possible supervision is essential in any case, and therefore this requirement of verticals cannot properly be accounted a disability. The chief advantage of horizontal retorts is that they will take any coking coal of any size and give satisfaction, and a change in the character of the coal within fairly wide limits does not affect their working. To get the best results in any method of carbonisation, blending is of great importance, but it must be carried out in the light of extensive knowledge of the properties of the coals dealt with. Mere partially-controlled blending of the two types of coal will not give the fullest advantage. In general, blending is of more advantage in horizontal retorts than in vertical retorts.

The relative advantages of low and high grade gas have in the past been the subject of bitter controversy. It is possible that low grade gas could be produced by complete gasification at a lower cost per therm, but its true position in relation to high grade gas must in every case be based also upon close analysis of its effects upon distribution and storage charges. Low calorific value gas involves the delivery of increased volumes, and since its specific gravity is also higher these two factors combine to make it more expensive to distribute, owing to their influence upon such factors as the size and cost of mains, distribution pressures, size and cost of meters and service appliances, etc.

The above considerations do not by any means exhaust all the points which have to be taken into account in the running of the gas industry. There is one point, however, which is perhaps not always appreciated as well as it should be, namely, the question of benzol scrubbing.

At the conclusion of the War the gas industry very rapidly dropped the extraction of benzol, the line of argument being that with gas at 10d. a therm the value of the heat content of the benzol, if allowed to remain in the gas, was the equivalent of 1s. 3d. a gallon. Before this benzol could be sold it had to bear the cost of extraction, and before it could be supplied to the internal combustion engine it had to bear the cost of distribution. Suppose, for the sake of argument, the cost of extraction is taken as 7d. a gallon and the cost of distribution to filling stations or in cans as 6d. a gallon; then the cost of gas works benzol, without including any profit, into the consumers' motor

car, would amount to 2s. 4d. per gallon. At first sight this appears to be a very potent reason why it may be more profitable for the gas industry to sell benzol as town's gas rather than in the liquid form ; but, although admittedly it would in any case be difficult to compete with petrol at its present price, it is doubtful whether such arguments are altogether sound. It must be remembered that since the gas supply has to be maintained benzol extraction would entail an increase in the amount of coal which has to be carbonised, and taking everything into consideration the cost of liquid benzol to the gas company might be considerably less than the figure assigned to it on the above assumptions. Further, gas works benzol is now protected to the extent of 4d. a gallon, and any increased extraction of benzol in gasworks for subsequent utilisation as motor spirit tends to national advantage by avoiding the importation of so much petrol. The difference may be very small, but it is all to the good.

The question of heating retorts is worthy of consideration in some detail. The built-in producer is at present the accepted method, but by adopting in suitable cases a centralised supply of clean producer gas the saving in retort repairs, the better control secured, etc., might more than pay for the loss of heat involved in not delivering hot gas direct from the producers. For experimental purposes the Fuel Research Station has always worked with a central supply of fuel gas delivered under pressure to the retorts. Accurate knowledge as to what effect the introduction of this practice would have in gas works is not claimed, but it is extremely likely that it would tend to better control of the heat. If the producer gas were clean and ash free this would be reflected in the cost of upkeep and deposits in combustion chamber. Again, by carrying a slight pressure in the combustion space, outleakage of coal gas would be obviated, and, instead, a slight leakage would take place inwards to the carbonising chamber. The disadvantage of inleaking is dilution in the " make " gas, but the disadvantage of leakage outwards is the consequent tendency of gases to ignite round the leaky places and cause rapid deterioration and failure of the retorts round these spots. A most striking illustration of this has recently been afforded at the Fuel Research Station, where after two years' working under pressure, the combustion chambers of the horizontal retorts were in a condition almost indistinguishable from new. (Fig. 5). Whilst cooled down the plant was inspected by a number of experts, including coke oven managers, who were all impressed with the success of this method of operation, which is largely due to the abilities of the Works Superintendent, Mr. G. Percival. It is understood that the method is being tried in one large gas works.

The question of heating the retorts by a proportion of their own coal gas during off-peak periods merits some attention. This has frequently been done at the Fuel Research Station when experimental work is not being carried out. With coal gas in its pure state difficulties may arise due to the formation of

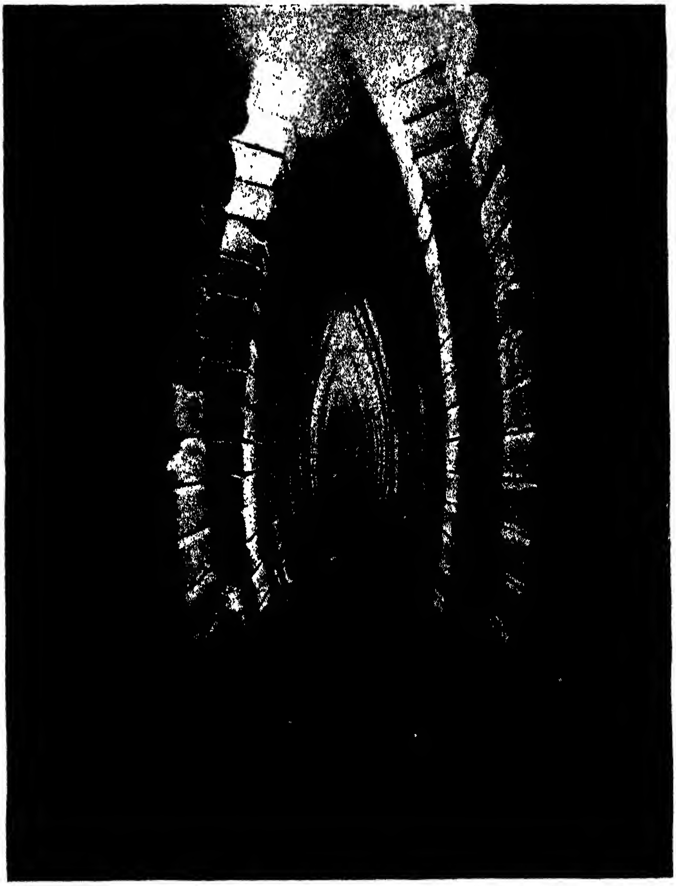

FIG. 5.
Combustion Chamber of Horizontal Gas Retorts at Fuel Research Station after working under slight positive pressure at 1350°C. for two years.

lamp-black, and careful supervision is required; but if the coal gas is subjected to a mild cracking process before being utilised, so that it is transformed into a rich producer gas, no difficulty at all is experienced with as much as 50% coal gas and 50% fuel gas made from coke, provided that proper precautions are taken. Similar experiments are being carried out by the industry and by the use of modified burning appliances it may become possible to utilise 100 per cent. coal gas.

Turning now to the question of coke, there is an undoubted demand at the present time for improved qualities. It is possible to produce gas coke which possesses many of the advantages claimed by newer types of low temperature fuels; but if present day developments continue, the market for gas coke may be seriously affected by the competition of cokes from other

processes, including that from coke ovens. In order to develop the fullest advantages of gas coke it is essential that it shall be (*a*) dry (*b*) clean and (*c*) screened. Dry coke can be obtained by greater attention to quenching. Clean coke can be made only from clean coal. At the present time the gas industry has to pay something like 2/- per ton more for cleaned than for uncleaned coal. This comparatively large increase in price is due to several factors, and introduces the question as to whether the gas industry should install their own cleaning plant. Gas companies, however, usually have to draw their supplies of coal from many sources, whereas cleaning plants are not appliances of the greatest flexibility, and in order to give the best efficiency must be adjusted to the type of coal dealt with. The correct place for cleaning plant is at the coal mines ; in this situation, when once adjusted to the optimum results from the collieries' coal, it would continue to work under the best conditions with very little trouble and adjustment. Again, the market for cleaned coal is not a large one, and even where cleaned coal is available it is likely to account for only a small proportion of the collieries' output. If, however, there were a greater demand from gas works for cleaned coal the cleaning operations of the collieries would be stimulated, and the price of the treatment should tend to fall.

This question of cleanness of the raw material cannot be stressed too strongly if a fuel is to be made for household purposes, whether by coke ovens, gas works or low temperature carbonisation plants, situated either at a colliery or at a gas works. Experience with low temperature coke has shown the amount of ash left in the grate to be a common cause of complaint from householders. It is a curious fact, although one capable of explanation, that 7 per cent. of ash in a coal burned in the raw state in a household appliance is much less obvious and less of a nuisance than 7 per cent. of ash in a coke of any kind.

Some of the considerations given above are equally applicable to coke oven practice, but it must be emphasised that, at any rate at the present time, the major output of the coke ovens is for blast furnace purposes. The blast furnace manager recognises the fact that he must have coke of a certain type and quality and he is willing to pay for such a coke.

Blending has been made some use of in the coke oven works of this country for many years, but it is now becoming an essential control factor in Continental practice. Some of the enormous installations on the Continent incorporate the most elaborate coal blending arrangements, which are supervised with the highest skill. During the last year or so attention has been paid on the Continent to the possibilities of blending with low temperature coke. For instance one works on the Saar, using a particularly fat form of coal, have had in the past to import a more feebly caking coal from a considerable distance. They have now experimented in the direction of using some of their very fat coal in a low temperature plant, and employing the residue so obtained as a blending material in the main coking works. The advantages

claimed are a considerable reduction in the carbonising time, and the production of a coke better suited to the purpose for which it is needed.

Such experience indicates the necessity of installing an experimental large scale coke oven plant in this country so that the effects of changes in working can be accurately studied. The present method of relying upon bag tests is uncertain and frequently gives misleading results. The tendency of industry in this country to look at the aggregate cost of the research work which it undertakes, and lose sight of its cost relative to the large interests involved, is to be deplored. The appointment by the Board of Trade on the recommendation of the National Fuel and Power Committee[20] of a Committee to consider the possibilities of closer co-operation between gasworks and coke ovens in a certain defined area is a step which will clear up many uncertainties and controversies in the particular fields concerned.

The type of work which has been described in this Lecture consists in obtaining improvements which result in the aggregation of a number of small economies, rather than in anything phenomenal, or anything which would provoke big headlines in the newspapers. Such work is often of a kind difficult to carry out satisfactorily by research associations, or in any industrial concern where large scale apparatus must defer to the interests and demands of consumers. The Fuel Research Station, on the other hand, is specially equipped for it. At the Station there is close contact with certain firms interested in fuel utilisation, as well as with technical people who are familiar with the various branches of the subject; but it would probably be an advantage both to us and to them if some closer measure of co-operation could be assured.

[20] Report of National Fuel and Power Committee (1928), p. 30.

WATER POWER IN SWITZERLAND.

In January, 1927, the rating of hydro-electric plant installed or in course of erection in Switzerland was given as 2,220,000 h.p., made up of 1,859,000 h.p. installed at the end of 1925, 41,000 h.p. put into service in 1926, and 320,000 h.p. building. In 1925 140,000 h.p. were installed. According to a report by His Majesty's Minister at Berne, the present development represents about one-fourth of the total power resources of the country.

The power output of Swiss electric works in 1926 is placed at about 4,000 million kwh., or roughly, 80 per cent. of the maximum available output. Power and light absorbed 2,250 million kwh., about 775 millions were exported, and a similar amount was consumed in the electro-chemical and metallurgical industry, whilst 200 millions were used for traction. Atmospheric conditions were fairly favourable for power production. A large station working on accumulation and completed in 1925, afforded valuable assistance in tiding over a period of drought at the end of the winter 1925-26. Exports of power are being looked upon as an increasingly valuable source of national revenue, and the steps taken by the Federal authorities in 1924 to bring about a more healthy state in export conditions are now bearing fruit. Considerable care is exercised by these authorities in issuing export licences. Contracts on an exchange basis were concluded in 1926 by some power companies for the export of surplus summer output and the import in winter of power produced by thermic stations abroad.

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THE TREATMENT OF COAL.

By C. H. Lander, C.B.E., M.Inst.C.E., M.I.Mech.E., F.Inst.P.,
Director of Fuel Research, Department of Scientific and Industrial Research.

LECTURE III.

(Delivered February 4th, 1929.)

The third and final lecture of this series is to be devoted particularly to a consideration of low temperature carbonisation and also of those chemical processes which have for their object the conversion of a much greater proportion of the coal substance into liquid fuels than can be effected by any method of carbonisation.

In view of the large amount of discussion, both at conferences and in the press, which has taken place on low temperature carbonisation during the last two years, it seems unnecessary at this stage to describe at length what low temperature carbonisation is, or to go closely into the benefits which it is claimed would result from a wide application of the system. Low temperature carbonisation has been put forward from time to time by interested parties as a panacea for various ills in such exaggerated terms as have tended to discredit it. On the other hand, largely owing to the painstaking efforts of certain groups of investigators, working in harmony with each other, there has undoubtedly been a great access of knowledge; and although there does not lie behind low temperature methods the wealth of practical experience and information which backs up the successful commercial operations of the established high temperature carbonisation industries, the technical problems

involved have now been largely overcome, and at the present time there is taking place in various quarters a steady development of types of apparatus based on sound principles. The time is definitely past in which the enthusiasm of over-sanguine promoters dare venture to make such claims as that low temperature carbonisation should be substituted entirely for high temperature gas works operations, or be applied generally as a preliminary process to all our coal. Much confusion has resulted from a lack of proper appreciation of the bearing of local conditions upon the commercial success or failure of low temperature methods. From time to time plants are reputed to be in commercial operation abroad, and in certain cases, although not so many as are sometimes supposed, with a foundation of fact; but here again the question is affected by the different requirements of the different countries. For instance, in America the problem presented is essentially dissimilar from our home problem. In the United States the primary requirement is not a coal substitute for use in the open grate, but a product which can be made from a cheap raw material and sold as a competitor of high-priced anthracites. Further, the liquid products in a country so rich in natural petroleum have not by any means the same significance as in the British Isles. It is obvious that when there is a large margin between the price of the raw material and the price which can be obtained from its resultant product, the chances of commercial success are greatly enhanced. In this country the claims made for low temperature carbonisation, which in the main are quite justifiable, are twofold. Firstly, it would provide a source of fuel for the domestic grate and so would tend to make the country much cleaner, since a large proportion of our smoke nuisance is derived from the burning of coal in these appliances. Secondly, since our geological formations are not able to provide directly any appreciable quantities of natural liquid fuel, we are forced to import from overseas a material which during the last twenty years has rendered itself vital to the continuance of the social conditions of the country in their present form. The quantities of oil and light motor spirits which are now used have become so great as to render it extremely unlikely that the complete replacement of sea-borne oil by a home by-product obtained from a carbonisation process could ever take place, but it is almost platitudinous to say that anything that could be done towards this end would be of great national advantage.

The question of national defence has often been emphasised in this connection, since very large quantities of liquid fuels of various kinds are essential in times of national emergency. Considerable stress was perhaps legitimately laid on this point some years ago, but the great growth in the estimated requirements for national defence now render it absolutely impossible to satisfy them except to a very small degree by a mere by-product. If, on the other hand, a really large proportion of the coal substance could be directly converted into oil, the position would be very different, and when discussing developments in the hydrogenation of coal, or the synthetic production of

motor spirit from water-gas, these arguments very properly come into the picture.

Although it is not feasible to discuss in detail the numerous designs of low temperature carbonisation plants which have been proposed, certain of the more outstanding types which have been tested by the lecturer in his official capacity will be briefly described at a later stage. It is of interest to note that all these can be separated broadly into two main groups, according to the method of application of heat. In one group are found a large number of systems in which the coal is treated in a gas-tight container, the heat being applied from the outside and having to traverse the walls of the container. Such processes may be either intermittent or continuous, but in general an intermittent or semi-intermittent system presents advantages in this type of plant. The second group comprises those plants in which the heat is applied internally by the introduction into the coal container of a heating medium, which is usually either some form of producer gas or super-heated steam, or a mixture of the two. Both of these methods have their advantages and disadvantages, and they are not really competitive. When a dense smokeless fuel in lump form for household purposes is required the externally-heated type of retort has certain obvious advantages. If, however, for the particular purpose in view the fuel is not necessarily required in the lump form, or if there should be some property inherent in the coal to be treated which renders it possible to produce a satisfactory proportion of lump fuel even by internal heating, this latter method makes for economy, since the time necessary for carbonisation is shortened.

The Fuel Research Board put the question of low temperature carbonisation in the forefront of the programme which they drew up some twelve years ago,[21] and they have worked steadily on with it ever since. Various methods were tried in the earlier stages of the investigation, but it was soon decided to pursue the work mainly along the lines of externally-heated retorts. As a preliminary the Board examined the results already obtained by various experimenters, but with one or two exceptions such results proved to be extremely nebulous, and, in addition, the whole subject was found to suffer from a certain lack of concentration. Inventors had tried to do too much at once; having obtained, for instance, a partial success on one type of coal they were immediately anxious to prove that their system could be extended to many other types; and so wasted time, money and energy in the exceedingly superficial survey of too wide a field. In certain cases, on encountering some difficulty in connection with details in plant design, there had been too great a hurry to change such details before the scientific factors governing the disability were fully understood. Few people stuck to a well defined path and resisted the temptation to explore by-paths until they had really found

[21] Report of the Fuel Research Board on their Scheme of Research and on the Establishment of a Fuel Research Station. (H.M. Stationery Office, 1917).

what their main work was leading up to. Serious failures occurred through the erection of large batteries consisting of a multiplication of units long before the unit itself had been properly tried out. In the early days very large amounts of money were squandered, and the whole subject offers a striking example of what has been aptly termed "research by catastrophe."

When the Fuel Research Board commenced its operations there were, however, several types of externally-heated plant which were the subject of careful and conservative development. One or two internally-heated types of retort were also under investigation in very able hands. The Scottish Shale Oil Industry had for many years successfully employed low temperature processes for the distillation of shale, and many useful data were available from this source. It must not be forgotten that this industry itself was originally started to develop James Young's patents for making lamp oil and paraffin wax from bituminous coal. The early operations of the gas industry also incorporated what were really low temperature methods, since carbonisation was carried out in cast-iron retorts which could not withstand temperatures much in excess of 600°C. to 700°C. The methods adopted, however, in these old industries required radical modification and development before it could be hoped to make a commercial success of the treatment at low temperatures of bituminous coal under modern conditions, an important factor in which is the competition of naturally occurring oil.

Up to the present it has not been definitely proved by anyone that commercial success has been obtained, and indeed the time has been too short for such definite proofs to be forthcoming. Many of the earlier plant by their inability to survive have demonstrated the difficulty of making a real profit, but so far no installation of reasonable size has reached the stage of being able to put forward a satisfactory audited profit and loss account. In this connection it is important to remember that the technical working of a plant is by no means the only factor controlling its commercial prospects, but that these are also affected to a considerable degree by local conditions. Further, successful commercial working is probably more dependent upon competent management than upon any other single factor.

Although the economic position of low temperature carbonisation must still be looked upon as somewhat uncertain, there is little doubt that the process is now definitely launched. Several large scale plants are already running, others are in process of erection, and reliable commercial data should shortly be available. The different systems will stand or fall according as they can or cannot pay dividends from the results achieved in ordinary day-to-day working.

The primary object of the work originally undertaken by the Fuel Research Board was to obtain systematic and accurate technical data relating to low temperature methods. It was obviously an impossible undertaking for any single organisation, however well equipped, to try out all of the many methods

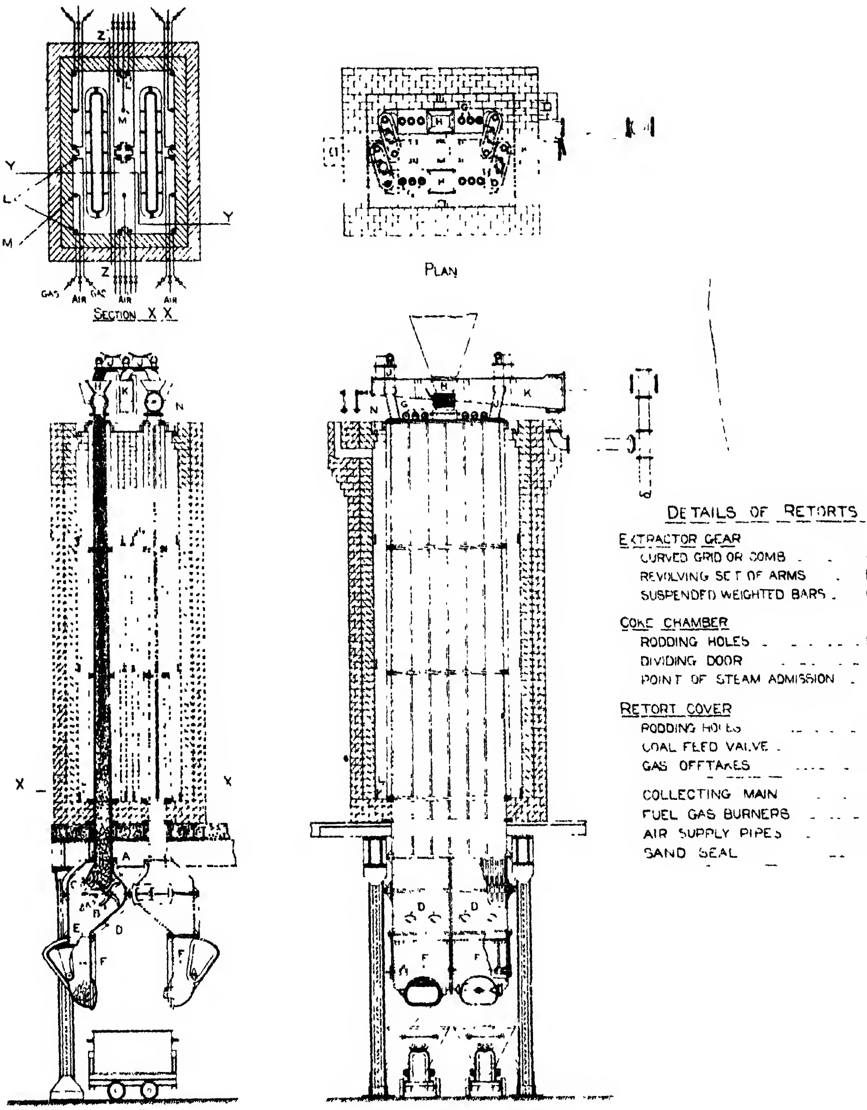
suggested ; on the other hand, at that early stage of the subject it would have been invidious to select any one proprietary process. Further, it was the policy of the Board to avoid as far as possible any duplication of work already being carried out effectively by industry.

For these reasons a small-scale horizontal setting, incorporating the method of external heating and designed essentially to meet the various ends in view, was erected at the Fuel Research Station.[22]

There was another direction, however, which appeared promising, but which had not been explored at the time, perhaps because it did not lend itself easily to the obtaining of patents ; and that consisted in an adaptation of the type of retort used in the Scottish shale industry, or indeed the ordinary continuous vertical retort of the gas works. After accumulating a large amount of data which was made available to other workers, from the small and intermittent plants, the first experiments in carbonisation by the method indicated were actually made in the high temperature retorts at the Fuel Research Station, the temperatures being reduced for this purpose. These further experiments were sufficiently promising to justify the erection of a setting of cast-iron vertical retorts designed essentially for low temperature carbonisation. These were of average section, 2 feet 6 ins by 1 foot and about 20 feet in height, which was substantially the same as the high temperature verticals already mentioned. The method of heating adopted, however, was considerably modified. As low temperature carbonisation implies, there need be no straining after high temperatures in the combustion chambers. Indeed the control necessary is usually far more important in the other direction, namely that the temperature on the metal of the retort itself shall not exceed a certain limit. This limit was provisionally fixed at 650°C., but owing to troubles experienced at that temperature it has been since reduced to 625°C.

The question of the most suitable temperatures for low temperature carbonisation has been the subject of some controversy. Temperatures lower than 600°C. may give larger quantities of liquid fuels, but except with special types of coal the lower temperatures are not in general conducive to the more robust types of smokeless fuel. Values of from 600-625°C. were therefore adopted at the Fuel Research Station as being likely to give a good hard coke, and a reasonable amount of tar and rich gas. After obtaining experience of the working of the original setting of continuous cast-iron vertical retorts these were replaced by other settings, in which the cross section was considerably modified. The retorts were made narrower across their minor axis in order to facilitate heat transfer through the coal mass ; at the same time they were lengthened out along their major axis. These retorts (Fig. 6) were roughly 7in. by 6ft. 3in. at the top, widening out to 11in. by 6ft. 9in. at the bottom, and were 21ft. high. The first setting of these new retorts gave fairly good

[22] Report of the Fuel Research Board for the years 1920, 1921, Second Section : Low Temperature Carbonisation, pp. 21 et seq. (H.M. Stationery Office, 1922).



SECTIONAL ELEVATION Y.Y.

SECTIONAL ELEVATION Z.Z.

SETTING OF CAST IRON RETORTS

FOR

LOW TEMPERATURE CARBONISATION

SCALE OF FEET

H.M. FUEL RESEARCH STATION, GREENWICH

FIG. 61

results, but for some time it was found impossible to reduce the breeze made to anything like a practical limit when continuous working was employed. The method of working was therefore altered, and for a time full intermittent working was resorted to, the breeze thereby being very much reduced, and the coke rendered more robust. This change, however, left the retorts exposed to the action of the incoming heat without there being anything to absorb it during the periods when they were empty between discharging and charging, and it became very difficult to ensure that the metal should not be subjected to temperatures greatly in excess of those known to cause growth and to produce other deleterious efforts. It thus soon became apparent that retorts of this type were not likely to have a reasonable life if worked on the intermittent system. A compromise was therefore tried, in which the level of the coal was allowed to fall periodically through a pre-determined distance, such, for instance, as 6 feet, every two hours, the vacant space being then immediately filled up with fresh coal By adjusting the fall and the periods it was found that various types of coal could be worked with, and indeed successful results have been obtained over many types of coal from feebly caking to the most strongly swelling varieties. In common with most vertical retorts, these low temperature retorts worked best with nut coal Alternatively fine slacks could be utilised, but the throughput was thereby reduced. The present method is to screen out the fines below ½in., which leaves a raw material ideally suited to the system. The fines can be dealt with in various ways, either by running some of the retorts with a reduced throughput, or by pre-briquetting the fines with pitch and supplying the resulting briquettes to separate retorts, or mixed in with the larger sizes of coal.

A semi-commercial battery of forty of these retorts has now been erected at the Richmond Gas Works by the Gas Light and Coke Company. (Figs. 7 and 8). In conjunction with these a setting of Hird retorts is also to be tried.

It is not necessary here to go in any detail into the negotiations which took place between the Government Departments concerned and the Gas Light and Coke Company before the arrangements were concluded for this semi-commercial trial, but it may be mentioned that Sir David Milne Watson was asked by the Government to select some one type of plant for experiment, the Government undertaking to guarantee the capital cost of the plant under the Trade Facilities Act. Under the agreement the plant would be run "as continually as is reasonably practicable" for a prolonged period in order to obtain accurate information both as to the technical and commercial possibilities of the method, the results of which would be made public.[23]

Careful consideration had already been given by the Government Departments concerned some three years ago as to the best way to stimulate the development of low temperature processes in private hands. Subsidies had been

[23] Report of the Fuel Research Board for the period ended 31st March, 1928, pp 4, 22, 24, 26. (H.M. Stationery Office, 1928).

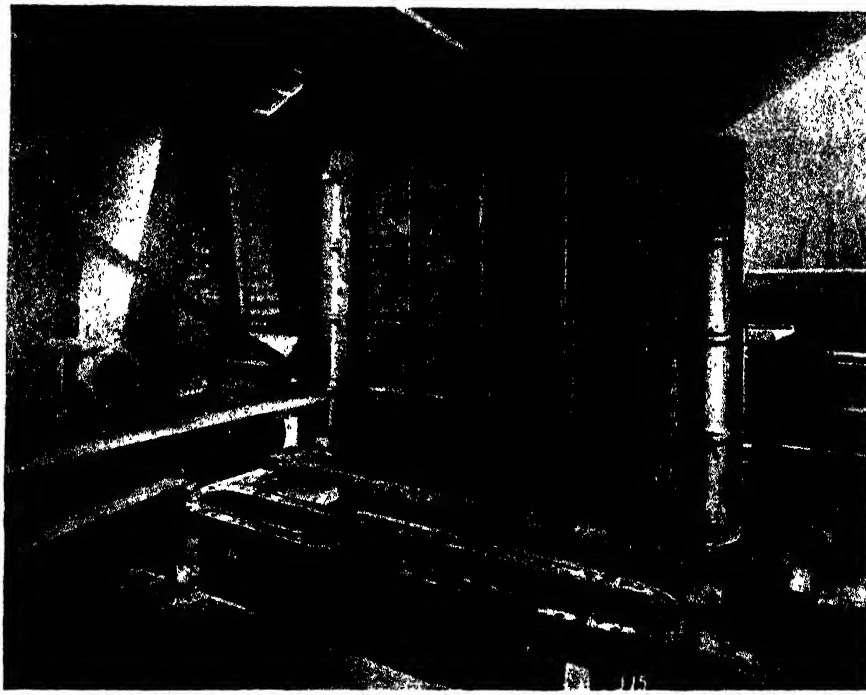


FIG. 7.
Cast Iron Vertical Retorts for Low Temperature Carbonisation under erection at the Richmond Gas Works.

suggested, and various schemes mooted for this purpose. The Department of Scientific and Industrial Research was not in a position to make a close investigation of the claims of inventors or companies, but could only accept or reject such data as were given to them, basing their conclusions perhaps on a visit of a few hours' duration by a member of the staff.

The Director of Fuel Research was therefore authorised at this stage to test at public expense, and without any charge to the promoter, such plants as claimed to have reached the full unit scale, and to be capable of increase to a commercial size by mere multiplication in number. Details of the conditions under which such tests are carried out were published.[24] Such facilities strengthen the position of promising plant by providing unbiased reports by an independent authority as to the working, yields, etc. under the conditions of a reasonably prolonged test. Complete independent tests of carbonisation plants had never previously been made, and it was quite obvious that the further development to the commercial scale would be considerably facilitated if such tests corroborated the claims made. On the other hand the necessity for some

[24] Report of the Fuel Research Board for the period ended 31st December, 1924. Appendix III, p. 71. (H.M. Stationery Office, 1925).

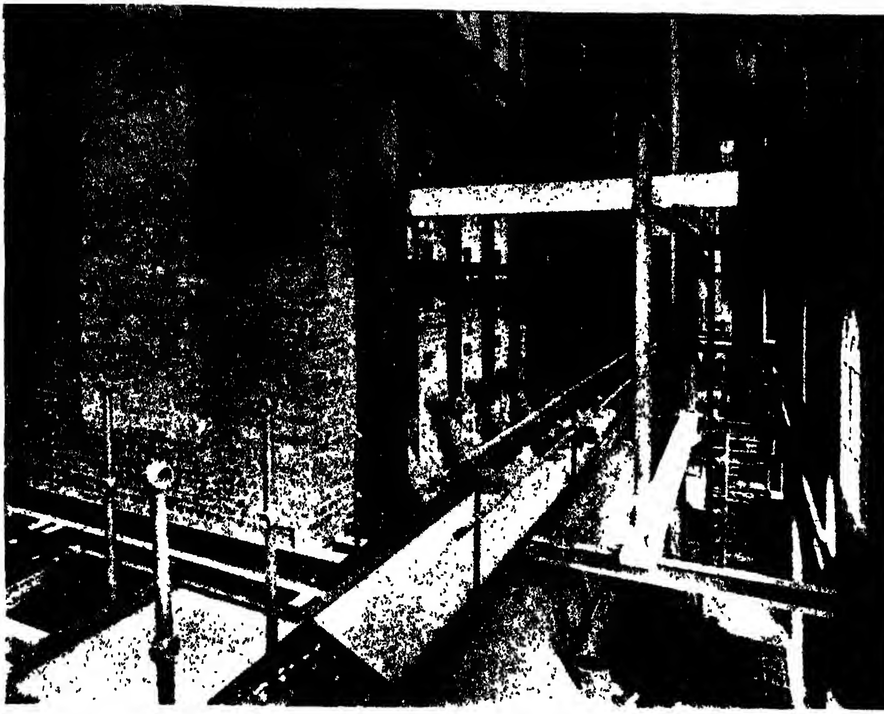


FIG. 8

Low Temperature Retorts at Richmond Gas Works, showing heating gas supply main and pipes.

such scheme as this was made evident by the confusion resulting from misrepresentation fostered by the over enthusiasm of the inventor or promoting group. Such tests were bound to clarify the position and to accelerate the progress of the sounder methods, and indeed the results have already justified the somewhat unusual course taken.

The plants which have been so far tested and reported upon are as follows :—

Low Temperature Carbonisation Ltd. (1924).—The installation of Low Temperature Carbonisation Ltd. which was tested consisted of a battery of thirty-two retorts. Each retort was formed from a single iron casting, through which were cored twelve vertical tubes, arranged in two rows. The casting was 9ft. in height and the tubes tapered from 5½in. diameter at the bottom to 4½in. diameter at the top. A coke cooling chamber was provided for each pair of retorts. During carbonisation the retort was separated from the cooling chamber by an iron swing door operated by a wheel on the charging platform at the top of the setting. A gas-tight door allowed access to the carbonisation chamber for discharging the coke. The retorts were enclosed in a brickwork setting forming combustion spaces for the heating gas, and were therefore externally heated.

Midland Coal Products Ltd. (1925).—This plant consisted of a battery of four retorts, each consisting of a long tapering vertical cylinder having an internal diameter at the top of 4ft. 4in. increasing to 5ft. 6in. diameter about 5ft. from the bottom. The bottom section was in the form of an inverted cone, the discharging door being at the apex. The total height of the retort chamber was 17ft. A ganister brick lining 15in. thick extended over the upper 12ft., the bottom cone-shaped chamber being water jacketed. About one foot above the widest part of the retorts there was a series of twelve tuyeres through which air and steam were passed to the interior. Each retort held about five tons. The material treated consisted of briquettes made from a feebly caking coal and medium hard coal-tar pitch. Carbonisation was carried out entirely by internal heating effected by burning part of the material charged into the retort. Air and steam were passed in at the tuyeres in the vicinity of which combustion took place. The hot gas passing upward on its way to the off-take pipes served to heat the incoming briquettes. The whole of the coke made had therefore to run the gauntlet of the combustion zone.

Fusion Process. (1925).—This retort consisted of a mild steel lap-welded tube 25ft. long and 2ft. 6in. in diameter, rotating in a horizontal position within a brickwork chamber which formed a combustion space for the heating gas. The retort contained metal breakers, which may be of various types; these were not fixed in any way. Each breaker was about 20in. in diameter, and was so arranged that as it rotated within the retort it kept the wall of the latter free from scale. Ingenious arrangements were provided for ensuring gas-tight connections between the rotating retort and the stationary appliances such as gas off-takes, etc. to which it was connected.

Freeman low temperature continuous retorts. (1925).—This retort was of the vertical continuous type, and about 27 feet high and 5 feet in diameter; it consisted of six cylindrical cast-iron chambers 18in. deep placed vertically above one another. A central shaft passed through the retort and attached to it in each compartment was a circular plate which rotated with the shaft. In the chambers, fixed to the top of the chamber and the underside of the rotating plate, were two series of ploughs, which served to push the material across the tables and floors from one chamber to the next and so through the retort. There were four off-takes at regular intervals round the top of every chamber, for removing the products of distillation. The heating was effected externally by gas burners and combustion spaces incorporated within the main castings.

Crozier retorts. (1927).—This retort was of cast iron and consisted of two parallel walls 1ft. 3in. apart joined by semi-circular ends. The height of the retort was 15ft. and the greatest width was 5ft. At each of five levels were three inclined cross flues, passing through the retort from one flat side to the other. Each cross flue had a cross section of the shape formed by the intersection of two arcs at an angle of 45°, the internal dimensions being 6in. wide by 9in. deep and the external 7in. wide by 12in. deep.

The retort was enclosed in a brickwork chamber built round it in such a manner as to leave a parallel space for heating gases. This space was divided into eleven compartments or flues one above the other, separated by fire-brick tiles, but communicating with one another through ports fitted with dampers. The compartments were so built that the first set of cross flues led from the first to the second compartment, the second set of cross flues from the third to the fourth compartment and so on.

Heating gases were supplied to the setting from a furnace burning either solid or gaseous fuel and communicating with the lowest heating space.

Maclaurin retorts. (1929). —This plant was of the type in which the coal is carbonised by internal heating by the combustion of a portion of the coke. The body of each retort or producer was 20ft. high, square in cross section, and lined with 18in. of firebrick. Except for the flat walls it was in shape not unlike a blast furnace, with a maximum width of 8ft. 3in. at a distance of 15ft. from the top. The retort then tapered uniformly in both directions and was 6ft. wide at the top and 6ft. 6in. wide at the bottom. Near the base it was divided into two equal parts by a vertical wall through which ran a pair of air channels, each conducting air to a series of twenty horizontal nozzles. Facing these were similar sets of nozzles supplying air through two outside walls of the retort. Steam was supplied with the air blast in order to reduce the possibility of clinker formation and to assist in the removal of volatile products from the producer. Steam was also admitted to the base of the producer, partly to cool the coke and also to seal the base of the producer during discharge.

Tests are also in hand on the Babcock and Wilcox (Mertz cycle), the N.T.U. and the Turner processes. All the processes already tested have substantially proved the technical claims made for them, and it will be seen that they typify both internally and externally heated plants. Table III summarises the yields obtained in the tests, together with some interesting comparative data furnished by several other firms for the purposes of the Carbonisation Conference organised by the Joint Fuel Committee of the Society of Chemical Industry, the Institution of Gas Engineers, the Coke Oven Managers' Association and the Institute of Fuel, and held at Birmingham in February, 1928.

Space would not permit of a more adequate description of the individual tests, but those who desire further information will find full details both of the plant and their operation in the series of official reports published.[25] It should

[25] Report of Test by the Director of Fuel Research on Parker Low Temperature Carbonisation Plant installed at Barugh, Barnsley, at the works of Low Temperature Carbonisation, Ltd. (H.M. Stationery Office, 1924).

Report of Test by the Director of Fuel Research on Carbonisation Plant of Midland Coal Products, Ltd., Netherfield, Nottingham. (H.M. Stationery Office, 1925).

Report of Test by the Director of Fuel Research on the "Fusion" Rotary Retort, installed at the works of Electro-Bleach and By-Products, Ltd., Cledford, Cheshire. (H.M. Stationery Office, 1926).

Report of Test by the Director of Fuel Research on the Freeman Multiple Retort of the British Oil and Fuel Conservation, Ltd., Willesden, N.W. (H.M. Stationery Office, 1926).

Report of Test by the Director of Fuel Research on the Crozier Retort, installed by Mineral Oils Extraction, Limited, at Wembley. (H.M. Stationery Office, 1928).

A report on the test of the Maclaurin Plant will be issued shortly.

TABLE III.—LOW-TEMPERATURE PROCESS YIELDS.

Name of Retort.	* Parker Process.	* Midland Coal Products.		* Fusion Rotary.	* Freeman Multiple.	* Crozier Process.	* Maclaurin Plant.	Leigh Smokeless Fuels, Ltd	Illingworth Carbonisation, Ltd.	Coal Extraction Ltd.	Salermo Process.	Fuel Research.
Name of Coal.	Dalton Main.	Kirkby Top Hards.	Briquettes as Charged (from Washed Slack)	Welbeck Cannel.	Kirkby Top Hards.	Fullygarth.	—	Caking Suitably Blended.	Rough Slack Caking.	—	Durham.	Dalton Main.
TAR—												
Yield of tar, gallons per ton ..	18.6	..	21.0	50.2	21 1	{16.4 / 2.4}	20.4 (wet)	20 0	17	..	20.3	17.3
Specific gravity	1.063	..	1.076	..	1.057	1.028	1 032	1.027	1.07	1.053	1.023	1.050
Spirit from gas gallons per ton ..	1.78	..	..	3.7	0.85	0.80	..	..	3 5	..	..	1.4
							typical tar					
Water	..	..	..	..	..	.	1.70	1.5	..	..	..	..
Up to 120°C.	..	..	..	..	..	.	0.64	..	..	..	..	..
Up to 170°C.	4.7	..	1.1	..	6.9	4.1	..	9.5	..	6.1	7.0	3.4
120°-230°C.	..	..	.	..	..	..	5.47	..	..	..	..	..
170°-230°C.	14.9	..	3.9	..	9 5	11.7	.	1.0	..	17.2	19.9	14.7
230°-270°C.	12.9	..	4.1	..	13 9	11.9	14.14	7.0	..	12.9	12.4	11.1
270°-300°C.	..	..	..	..	..	..	..	..	..	..	..	..
270°-310°C.	18.1	..	..	..	.	..	..	13.0	..	..	11.2	..
270°-330°C.	..	..	..	..	..	15 7	..	..	..	..	..	..
270°-345°C.	..	..	..	..	.	..	26 04	..	..	..	..	23.4
270°-360°C.	..	..	26.9	..	20.8	..	..	..	..	23.0	..	..
300°-350°C.	..	..	..	..	..	..	..	15.0	..	..	..	..
Pitch	48.4	..	63.2	..	39.3	55.9	48 50	23.0	..	40.7	48.7	45.8
Loss	1.0	..	0.8	..	0.6	0.7	3.51	..	..	..	0.8	1.6
Tar acids	17.0	..	13.4	..	24 5	14 3	..	..	.	25.5	..	..
GAS—												
Volume of gas, cu. ft. per ton ..	5,620	..	58,300	2,740	1,720	..	33,849	10,000	6,200	3,505	3,920	5,188
Calorific value, B.Th.U. per cu ft.	700	..	193	1 070	895	..	239 5	350	780	814	870	719
Therms	39.6	..	112.5	29.3	16.1	.	81.1	35	48.4	28.5	34.1	37.3
CO_2	4.0	..	1.6	6.5	10 2		7.0	..	..	4.5	..	4.0
CnHm	4.3	..	..	13 2	5 4	.	0.4	..	..	5.2	..	3.4
O_2	1.0	..	*Nil*	1.0	1.4	..	0.4	..	..	1.6	..	1.0
CO	6 1	..	28.1	6.4	6.7	..	12.2	..	..	5.9	..	6.6
H_2	37.2	..	16.6	17.1	6 1	..	20.2	..	..	15.0	..	31.3
C_nH_{2n+2}	39.6	..	4.4	49.5	50.4	..	12.9	..	..	53.0	..	42.6
N_2	7.8	..	49 3	6 3	16.8	..	46 0	..	..	14.8	..	10.6
" n "	1.23	..	..	1.59	1.4 (about)	.	.	..	..	..	..	1.27

* Plants tested by Fuel Research Board Staff.

TABLE III.—LOW-TEMPERATURE PROCESS YIELDS

Name of Retort	* Parker Process.	* Midland Coal Products		* Fusion Rotary.	* Freeman Multiple	* Crozier Process	* Maclaurin Plant	Leigh Smokeless Fuels, Ltd	Illingworth Carbonisation, Ltd	Coal Extraction Ltd	Salermo Process.	Fuel Research.
Name of Coal	Dalton Main	Kirkby Top Hards.	Briquettes as Charged (from Washed Slack)	Welbeck Cannel.	Kirkby Top Hards.	Tully-garth	—	Caking Suitably Blended	Rough Slack Caking.	—	Durham.	Dalton Main.
Analyses of Coal.												
Moisture	2.4	9.6	14 5	1 8	9.4	11 4 (As charged wet weather)	10 0	*Nil*	1.6	2 7	1.7	2.5
Volatile matter *less* moisture .	35.8	32 5	33 3	46 6	32 1	34 0	33 7	33 0	33 0	14 5	32.9	32.6
Fixed carbon	57.2	52.0	47.1	36 8	51 0	44 2	50 7	62 5	54 0	78.3	60.4	58.5
Ash	4 6	5.3	5 1	14 8	6 9	10.4	5 6	4 5	11 4	4.5	5 0	6.4
Caking index	19	..	..	..	..	4	up to 16	caking blends	caking coal	..	caking	16
Ultimate analysis (dry coal) -												
Ash	4.75	5 94	5 97	15 00	7 73	11 77	.	..	..	..	..	6.2
Carbon	80.05	77.72	77 36	70 20	75 03	71 40				..	..	80.1
Hydrogen	4.95	4.91	4 46	6 32	4 83	4 84		.	..	..	..	5.0
Sulphur	1.10	0 96	1.21	0 78	1 50	0 50		.	..	.	..	1.5
Nitrogen	1 00	1.94	1 47	1 50	1 30	1 55		..	.	..	..	0.9
Oxygen, etc.	7.40	8 53	9 53	6 20	9 19	9 01	.	..	..	..	..	6.3
SOLID PRODUCT—												
Cwt. per ton	13.9	..	7 5	11.7	13.3	15 4	7 9	14 0	15 2	..	15.2	15 1
Volatile matter, p. ct. . ..	4.0	..	2.0	9.7	15 2	14 0	4 to 6	4 5	5 to 6	..	9.0	6.8
Breeze through ¼in. sq. mesh ..	4.6	..	15.0	99.0	59.3	17 4	about 10	Nil	5.3	..	64 8	17 2
Temperature of carbonisation, °C.	550-850	..	up to 1200	550	500	up to 470-520	..	.	600	..	450	625

be clearly understood that no attempt is made to pronounce upon the commercial possibilities of plant which may be tested. The likelihood of commercial success can only finally be judged after working a plant under a steady load for a long period, and in the light of complete knowledge of local conditions such as cost of raw material, quantity of raw material available, price and markets for products, cost of labour, etc.

It will be observed from the table that the yield of tar to be expected from low temperature carbonisation is of the order of 16-25 gallons per ton of coal, and although higher yields might be obtained under exceptional circumstances it is not likely that the figures could be increased by more than say 30 or 40 per cent. If, therefore, the conversion of a really large proportion of the coal substance into liquid fuels is sought, the aid of other processes must be enlisted. Two alternative methods which, during the past few years have been much in the public eye are the Bergius process for the direct hydrogenation of coal, and the hydrogenation of carbon monoxide produced from coal, which was described initially by the Badische-Anilin-und-Sodafabrik and followed up and extended by Fischer in Germany and Patart and Audibert in France.

The direct hydrogenation process, which consists in adding hydrogen to the coal substance under conditions of elevated temperature and pressure, has been shown by experiments both at the Fuel Research Station and elsewhere to be capable of producing from 110 to 130 gallons of distillable oil per ton of coal treated, although an additional quantity of coal may be required for power and hydrogen production.

The introduction of a solid material such as coal into a vessel containing hydrogen under a pressure of 200 atmospheres naturally presents a problem of considerable difficulty. Bergius has solved this by mixing ground coal with a liquid organic vehicle so as to form a paste which can be pumped by special appliances. To this mixture is added a small proportion of iron oxide to act either as a catalyst or as a means of removing sulphide of hydrogen in the gases evolved. In the continuous type of plant used at Mannheim and at the Fuel Research Station three reaction vessels or bombs are arranged in series, the first being maintained at about 460°-480°C., and the two final ones at about 490°C. The exact temperatures required in the final bombs are somewhat critical and depend on the type of coal used. The product leaving the last bomb is cooled and its pressure reduced in two stages, firstly to 60 atmospheres where the gas evolved is scrubbed with oil in order to extract motor spirit, and secondly to atmospheric pressure where the final crude product is collected.

The final crude product contains the whole of the inorganic matter of the coal, together with the added iron oxide and a certain amount of partially converted solid material. These solids have to be removed before distillation can be effected. A typical example of the yields per ton of coal obtained in the continuous plant (one ton per day) at the Research Station is as follows :--

YIELDS PER TON OF COAL.

Hydrogen Consumed = 114 *lb.*

Fraction	0°—175°	=	83 lb.
,,	175°—230°	=	208 ,,
,,	230°—270°	=	197 ,,
,,	270°—310°	=	105 ,,
,,	310°—360°	=	208 ,,
	Pitch	=	329 ,,
Gas Benzine		=	42 ,,
Bergin Gas		=	325 ,,
Unconverted Coal		=	363 ,,
Water		=	179 ,,
Coal Ash		=	161 ,,
Loss		=	154 ,,
			2354 ,,

As a general statement it will be recognised that the products from the hydrogenation of coal contain a greater quantity of saturated organic compounds than those obtained from low temperature carbonisation, and consequently the treatment of the oil from the point of purification should not be so intricate as is necessary for the treatment of low temperature tars.

It would appear that the chief value of the fractions will be either as a motor spirit or as fuel oil, although there are indications that certain of them may be of value as lubricating bases.

In undertaking hydrogenation investigations upon the coal seams in this country it has been necessary to carry out a great number of experiments in small experimental bombs. These experiments have been carried out in batches, the process not being continuous, and in attempting to correlate the results with those obtained in the continuous plant considerable differences have been encountered in the behaviour of various coals. Certain coals, for instance, which will hydrogenate readily in an experimental bomb have been found not to be workable in a continuous plant. In view of this it is apparent that an entirely false impression of the character of a coal may be obtained if the results are not correlated directly with continuous working.

In planning the investigations upon hydrogenation at the Fuel Research Station it was decided that one of the most important aspects of the problem was to determine the exact part played by the hydrogen in converting the coal into oil, and in order to trace out the effects step by step it was decided to hydrogenate coal fractionally and to interrupt the processes of hydrogenation at a series of stages. The first result of this investigation has led to a most interesting observation. It has been found that in experiments in which an

extremely small amount of hydrogen has combined with the coal the first effect is to produce a material which is fluid at the temperature of the reaction but becomes solid on cooling. This product possesses some interesting properties but it has been studied especially from the point of view of its behaviour on carbonisation. Its caking properties have been found to be much greater than those of the coal from which it is obtained, and even when the coal used is a non-caking coal the product may possess very high caking properties.

It would, therefore, appear that it is possible to confer on coals caking properties which may be in excess of those possessed by any naturally occurring coal. It has been found that as the amount of hydrogen combining with the coal is increased, the caking property is also increased, with an increase in the oil produced when the product is distilled.

The following is an example of an experiment in which the interaction of about 1 per cent. of hydrogen by weight of the coal substance gave a strongly caking product.

Conditions.

Initial Pressure Kg.p.sq.cm.	100
Maximum Pressure	245
Final Pressure	87
Maximum Temperature °C.	360
Period of Heating mins.	95

Products.

Solid	gm.	218.4
Water	,,	22.3
Gas	,,	21.2
Loss	,,	1.6

Hydrogen Reacting.

Per cent. of dry ash free coal. 0.8

This observation has led to a more accurate knowledge of the part played by the hydrogen in the transformation of coal into oil, and it has been observed that in the first instance the effect of the hydrogen appears to be to eliminate oxygen from the coal substance, since a large proportion of the oxygen appears in the products from the hydrogenation in the form of water. At the same time the percentage of hydrogen present in the product is less than that found in the original coal. The phenomenon is being explored from a number of angles and it is not possible at this stage to explain fully the mechanics of the reactions. Although probably of great importance in the future, the process of hydrogenation, at any rate so far as the bituminous coals of this country are concerned,

is not able to make oil as yet at a price anywhere near that of the cost of similar fuels obtained from natural sources.

In other methods for the production of synthetic fuels from coal the first step is to break down the complicated molecules of the coal substance into carbon monoxide and hydrogen by the action of steam upon the red-hot carbonaceous matter according to the water-gas reaction

$$C + H_2O \rightleftharpoons CO + H_2$$

A recombination of these molecules is then effected by the action of heat in the presence of a suitable catalyst. The subsequent products range from oxygen-containing compounds such as methyl and ethyl alcohol to liquid and solid hydrocarbons, for instance, of the paraffin series.

In the process developed by Patart, water gas made from coal or coke is led through water scrubbers and sulphur purification apparatus to a gas holder.

From this it is compressed into electrically heated catalyst tubes by a compressor capable of reaching 300 atmospheres. For the production of methyl alcohol it is stated that temperatures of about 380°C. are the most suitable, while for motor fuel manufacture 450°C. is required.

In the Fischer process the combination of the carbon monoxide and hydrogen is effected at atmospheric pressure with the production of liquid and solid hydrocarbons of the petroleum series, oxygen-containing products in this case being absent.

It is evident that such synthetic processes as those described cannot be carried out without considerable thermal losses. The separate steps of a process all involve heat treatment of the material, and in converting the coal into coke and in the subsequent steps of water gas manufacture and catalytic action, some loss is inevitable. To what extent such losses will react upon the economics of the process and affect the commercial prospects of full-sized unit plants actual working experience alone can tell. High priced products such as methyl alcohol are already being made commercially by these methods, but it does not appear to be possible at present to operate such processes on a satisfactory financial basis for the manufacture of liquid fuels in this country.

THE LIBRARY.

The following books have been presented to the Library since the last announcement :—

Adams-Acton, Murray, F.S.A. Domestic Architecture and Old Furniture London : Geoffrey Bles.

Applied Chemistry, Reports of the Progress of. Vol. 13. 1928. London: Society of Chemical Industry. 1929.

Bird, W. Hobart. Old Gloucestershire Churches. London : Ed. J. Burrow & Co., Ltd.

Brooks, C. E. P., D.Sc., and J. Glasspoole, M.Sc., Ph.D. British Floods and Droughts. London : Ernest Benn, Ltd. 1928.

Cockerell, Douglas. Some Notes on Bookbinding. Oxford University Press. (London : Humphrey Milford.) 1929.

Coles, L. A., B.Sc. An Introduction to Modern Organic Chemistry. London: Longmans, Green & Co. 1929.

Crennell, J. T., B.A., and F. M. Lea, M.Sc. Alkaline Accumulators. London: Longmans, Green & Co. 1928.

Cundall, H. M., I.S.O., F.S.A. A History of British Water Colour Painting. Second Edition. London: B. T. Batsford, Ltd. 1929.

Fletcher, Harvey, Ph.D. Speech and Hearing. London: Macmillan & Co., Ltd. 1929.

Hartley, Dorothy, and Margaret M. Elliot, B.A. Life and Work of the People of England: The 14th Century and the 17th Century. Two Volumes. London: B. T. Batsford, Ltd. 1928.

Hawkins, L. M. Allegiance in Church and State. London: George Routledge & Sons, Ltd. 1928.

Hilditch, T. P., D.Sc., F.I.C. Catalytic Processes in Applied Chemistry London: Chapman & Hall, Ltd. 1929.

Holloway, Edward Stratton. American Furniture and Decoration—Colonial and Federal. London: J. B. Lippincott Company. 1928.

Houstoun, R.A., M.A., D.Sc. Intermediate Heat. London: Longmans, Green & Co. 1928.

Hubbard, E. Hesketh, R.O.I., R.B.A. 1. On Making and Collecting Etchings. Breamore: The Print Society. (London: B. T. Batsford, Ltd.). 1924. 2. Colour Block Print Making. Breamore: The Forest Press. 1927. 3. How to distinguish Prints. Breamore: The Print Society. 1926.

Joseph, Bernard, B.A., B.C.L., Ph.D., Nationality—its Nature and Problems. London: George Allen & Unwin, Ltd. 1929.

Joseph, Philip, LL.B., Ph.D. Foreign Diplomacy in China, 1894-1900. London: George Allen and Unwin, Ltd. 1928.

Lister, Walter. Practical Steelmaking. London: Chapman & Hall, Ltd. 1929.

Littlejohns, J., R.B.A. Art in Schools. London: University of London Press, Ltd. 1928.

Lloyd, Nathaniel, O.B.E., F.S.A. Building Craftsmanship. Cambridge University Press. 1929.

Lockyer, Sir Norman, Life and Work of, by T. Mary Lockyer and Winifred L. Lockyer. London: Macmillan & Co., Ltd. 1928.

Lyman, Theodore, Ph.D The Spectroscopy of the extreme Ultra-Violet. Second Edition. London: Longmans, Green & Co. 1928

Mantell, C. L., Ph.D. Industrial Carbon. London: Chapman & Hall, Ltd. 1929.

Noble, Edwin. Animal Drawing and Anatomy. London: B. T. Batsford, Ltd. 1928.

Oxford, Catalogue of a loan Exhibition of Silver Plate belonging to the Colleges of the University. Oxford: Clarendon Press. 1928.

Pearse, A. S., and F. G. Hall. Homoiothermism London: Chapman & Hall, Ltd. 1928.

Roberts, Stephen, H., M.A., History of French Colonial Policy, 1870-1925 Two Volumes. London: P. S. King & Son, Ltd. 1929

Rowe, J. W. F., M.A., M.Sc. Wages in Practice and Theory. London: George Routledge & Sons, Ltd. 1928.

Sawer, D. D. Everyday Art at School and Home. London: B. T. Batsford, Ltd. 1929.

Smith, Neil Skene, B.Com. Economic Control. London: P. S. King & Son, Ltd. 1929.

Stephenson, James, M.A., M.Com., D.Sc., Bedrock of Modern Business. London: Sir Isaac Pitman & Sons, Ltd. 1929.

Strzygowski, Prof. Josef. Early Church Art in Northern Europe. London: B. T. Batsford, Ltd. 1928.

Taylor, Frederic H. The Installation of Electric Lighting and Heating. London Chapman & Hall, Ltd. 1928.

Tinkler, C Kenneth, D.Sc., and Helen Masters, B.Sc. Applied Chemistry. Vol. 1. Second Edition. London: Crosby Lockwood & Son. 1929.

Todd, Dorothy, and Raymond Mortimer. The New Interior Decoration. London: B. T. Batsford, Ltd. 1929.

Villiers-Stuart, C. M. Spanish Gardens. London: B. T. Batsford, Ltd. 1929.

Wall, E. J., F.C.S. Practical Color Photography. London: Chapman & Hall, Ltd. 1929.

Woodhouse, Thomas, and Peter Kilgour. Jute and Jute Spinning. Two Vols. London: Macmillan & Co., Ltd. 1929.

NOTES ON BOOKS

HOMOIOTHERMISM. The Origin of Warm-Blooded Vertebrates. By A. S. Pearse and F. G. Hall. New York: John Willey & Sons, Inc. London: Chapman and Hall, Limited. 10s. net.

The authors give to the main-title, "Homoiothermism," a rather notable prominence, this expression being the only indication as to subject matter on the outside of the book, on the half-title-page, or as a running title over the alternate pages. Taken alone we can imagine it as a possible, but rather far-fetched title for a treatise on Kelvin's principle of energic dissipation; but a careful reading of the whole book shows the volume itself as strictly true to that sub-title which we find but once printed in very small type on the main title page, and which we give above. As a study of the probable evolutionary origin of the higher vertebrata, the book deserves special notice.

The treatise opens with a study of conditions for an optimum vital metabolism, as affected by temperature; all higher vertebrates depending on cells that "live at a rather constant temperature"; this temperature being "close to the optimum for their special metabolic activities" The authors point out that C. Lusk suggested, in his study on nutrition, that constant-temperature vertebrates "originated along the shores of tropical oceans, which continually had a rather high temperature, to which these animals gradually became adjusted." (p.2 and p.108.)

Characteristics of animals that, when in health, live at a "rather constant" body-temperature, like birds and mammals, are contrasted with the low-temperature vertebrates, which often tolerate, or even seek such high temperatures as raise the body temperature considerably; sometimes as high or even higher than the body-temperature of a bird or a mammal. Very varying aspects of tolerance are considered in Chapter IV, where, on p. 18, is a closely printed tabulation of the body-temperatures in representative lower animals, which are characterised not only by being cold-blooded in comparison with birds and mammals, but which are inconstant as to temperature in the sense that their vital metabolisms can function, despite a wide range of body-temperature, without death from cold or death from fever resulting. These inconstants as to temperature are all animals below birds and mammals; indeed the medusa, with a body temperature about one-fourth of a degree over the environment (Valentine), heads the list. The oyster is quoted as having a body-temperature "the same as the water" and a normal vital range of body-temperature of 82 degrees F. (Davy); a range only exceeded in the tabulation by certain amphibia: 86 degrees. The frog closes the tabulation; Berthold being the authority for stating that when in water its temperature is that of the water.

Chapter V is headed "Responses of Homoiotherms to Variations in Temperature,"

In the first few lines of this Chapter we are reminded that the average body-temperature of all mammals is about 39 deg. C. ; of man about 37, and of birds about 44. A graph on p. 31 shows at a glance all the fundamentals, while the final two paragraphs of the Chapter indicate briefly those principles of temperature regulation in the higher grades, which are afterwards considered under various headings ; as for example, "Mechanisms of Temperature Regulation," p. 56, "Effects of Decerebration and Spinal Sections on Thermo-regulation," p. 64, "Fever," p. 66, and "Fitness of Temperature Constancy," pp. 89-95.

The main ideas are easy to grasp, as they are given without an overburdening bulk of historical matter ; the older Evolutionists from Empedocles to Charles Darwin being practically neglected, except by tacit acceptance of main features ; but Sir George H. Darwin (fourth in the illustrious sequence of five Darwins) is specially mentioned and considered in Chapter II, "Temperature of the Earth in Time and Space." The earth and the individual seem linked into kinship, perhaps rather hastily, by a suggestion on p. 90, due to Macallum, that when the protovertebrate types first acquired a kidney, the degree of salinity or osmotic pressure of their blood corresponded with that in the ocean of the time and place.

This leads us to Erasmus Darwin, who from the standpoint of evolution may be termed Darwin I in the sequence of five. The best edition of his last book, "Origin of Society," by the sub-title, or "Temple of Nature" by the first or main title, is the octavo edition printed at Glasgow by the University printers and dated 1825, or about 23 years after the issue of the first edition and the death of Erasmus Darwin. Here the warm ocean in which organised vitality is supposed to have had its origin is regarded as saltless or nearly so, like our ordinary water supplies ; saline impurities having drained into the ocean slowly and irregularly. Darwin's "Origin of Society" is the first systematic, detailed and consistent work in which bodily man, his mentality and all his works, are displayed as in sequence to natural laws, or as "images of the operations of nature" The quoted words occur in Darwin's short preface to the first edition, dated from the "Priory near Derby, Jan. 1st, 1802." The death of Erasmus Darwin took place on April 18th following.

Much that bears on the volume under notice is in Erasmus Darwin's "Origin of Society." A footnote on Darwin's p. 56 touches on increase generally ; especially in the mass of the earth, and so is partly in unison with Chapter II of the volume under review, which includes the speculations of Chamberlain and of Darwin IV, (George H.). Darwin I seems to think that our earth has increased by many additions coming to a somewhat irregular granitic mass surrounded with water, so as to form an unbrokenly tidal spheroid like that imagined by Babbage ; see p. 248 of the 1838 edition "Ninth Bridgewater Treatise." Erasmus Darwin, in his Origin of Society, emphasises the warm ocean as indirectly building the cretaceous and magnesian hills, also the vertebrates until "Cold gills aquatic form respiring lungs." On p. 56 the principle of universal law is considered by Darwin as under Nature's Lord, who :—

> "With heat and light revives the golden day,
> And breathes his spirit on organic clay ;
> With hand unseen directs the general cause
> By firm, immutable, immortal laws."

As an easy suggestive, carefully accurate, and lucid study of heat, matter and law in what is generally now known as evolution, the work under review deserves a wide circulation in edition after edition ; but we hope the ill-fitting combination "Homoiothermism" may in some way be eliminated, so that one may quite unfetteredly think and speak of the book as "Pearse and Hall on the 'Origin of Warm Blooded Vertebrates.'"

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

EXHIBITION OF INDUSTRIAL DESIGNS.

The Exhibition of work selected by the Judges at the Sixth Annual Competition of Industrial Designs, which has been on view by kind permission of the Board of Governors, in the Exhibition Pavilion of the Imperial Institute since August 3rd will be closed on September 1st.

The Exhibition is open free of charge, and no tickets are required. It includes designs for Architectural Decoration, Textiles, Furniture, Book Production, Pottery and Glass, Posters, Showcards, etc.

The Exhibition has been visited by many manufacturers and others specially interested, and also by the general public. A considerable number of designs have been sold.

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES.

THIRTY YEARS' EXPERIENCE OF INDUSTRIAL MALADIES.

By Sir Thomas Morison Legge, C.B.E., M.D.,
late H.M. Senior Medical Inspector of Factories.

I.

Notification of Industrial Diseases.

(*Delivered February,* 1929.)

After twenty-seven years work in the Factory Department and comparison of the conditions then in factory and workshop with those which exist to-day I am amazed with the progress made in the interval. Perhaps it is most

noticeable in illumination and locally-applied exhaust ventilation. In the early days I used to see rooms warmed by lighting gas jets and a naked bat's wing flame on a moveable bracket was the means of illumination to a lathe or loom. When I visited all the white lead works in 1899 in only two of the twenty-three was there a vestige of a primitive form of exhaust ventilation for the removal of dust. So it was, too, in the 860 brass foundries in Birmingham when I visited some of them in 1903 on the quest of those suffering from brass founders' ague. Now every white lead factory is equipped with a system of locally-applied ventilation, and the conditions in brass-casting workshops from somewhat similar provision are vastly better than those I can remember. But more important than that is the spirit of invention in the trades themselves in the discovery of labour-saving devices.

I willingly and readily give praise to the unknown public behind the Home Office for the urge and movement which it has set going. Although the powers that be there may appear to be slow and tardy in their consideration of reports and in action upon them, the wheels grind fairly surely and finely in the end. To an impatient and impetuous person like myself (and if so to me, how much more to workpeople who cannot realise the difficulties on one side and another!) the delay of one year, two years, or often much longer in fulfilment of what at first sight seems so obvious, is hard to bear. But I am convinced that long consideration given to a subject which is to be dealt with lastingly is right and makes the chance of success greater. Time is so short that it is an unimportant factor compared with a happy and unanimous ultimate solution. Perhaps it will be so with one or other of the Factory Bills in God's good time!

I am here talking only of matters with which the Home Government is concerned, and not with international agreements or conventions, where we have not been so successful—at any rate in carrying them out.

Many of the subjects dealt with have been and are extraordinarily complex and difficult. Take, for instance, two only--silicosis and skin cancer. Thirty years ago the public conscience was stirred about lead poisoning and "Phossy jaw." We have, however, dodged phosphorus necrosis, and we know, at any rate, how to deal with practically all the manifestations of lead poisoning, although this is not the same thing as saying that we have always acted accordingly. And so in time will it be with silicosis and skin cancer. The second will be more easily dealt with than the first and probably by the experimental finding of an oil which is free, or can be freed, from the carcinogenic properties present in lubricating oil as used to-day. It may take a long time to find, but that it will be found eventually I have no doubt. Silicosis is more difficult to tackle. Substitution of artificial stones composed of *silicates* (carborundum, etc.) is one partial solution in the grinding industry, and, failing that, sluicing the stone with water to an extent that has not been done before is another. Meanwhile effort to stop the dust in one way or another, must be the main safeguard.

Throughout these lectures I shall lay stress, as a kind of test, on three axioms which experience has led me to enunciate. They are:—(1) Unless and until the employer has done everything the workman can do next to nothing to protect himself. (2) If you can bring an influence to bear external to the workman (i.e., one over which he can exercise no control) you will be successful; and if you can't, or don't, you won't. (3) All industrial lead poisoning is due to the inhalation of dust and fumes; and if you can stop their inhalation you will stop the poisoning. It is not due to dirty hands (i.e., eating with unwashed hands).

Examples of the influences I have in mind are:

(1) Prohibition, e.g., by the substitution of sesqui-sulphide of phosphorus for yellow phosphorus (effected by the Berne Convention).

(2) Conversion of pulp white lead into oil paint ready for the market in automatic closed-in machines without dry grinding.

(3) "Low solubility glaze" in pottery manufacture, by which the same amount of raw carbonate of lead may be used, but so combined in calculated quantity with siliceous material in a "frit" as to be practically insoluble in the gastric juice.

(4) Plastic rubber, that is, rubber in which lead oxide has been incorporated in a "mother batch" to the extent of 90 per cent., thus abolishing production of lead dust in later processes (first put into practice by Mr. C. A. Klein, Chemist to the Associated Lead Manufacturers Ltd.).

(5) Disinfection of anthrax-infected wool by formaldehyde—the Duckering process—as carried out in the Government Wool Disinfection Station, (Home Office) Liverpool; and finally, though not quite so successfully,

(6) Locally-applied exhaust ventilation by a fan.

Examples of influences, useful up to a point, but no remedy, which are not external, but depend on the will or whim of the worker to use them, are respirators, gloves, goggles, washing conveniences and waterproof sand-paper.

In the expiring hours of the Rosebery Government, after its defeat, Mr. Asquith, the then Home Secretary, placed the Factory and Workshop Act, 1895, on the statute book, section 25 of which called on every medical practitioner attending on or called in to visit a patient whom he believed to be suffering from poisoning by lead, phosphorus or arsenic, or from anthrax contracted in a factory or workshop, to notify it to the chief inspector of factories at the Home Office. A similar duty was imposed on the occupier to report every case to the inspector of factories and to the certifying surgeon. A further sub-section gave power to the Secretary of State to add other diseases to the list as, and when, he thought necessary. In 1901 mercury poisoning was added in consequence of incidence in hatters' furriers' workshops and in the manufacture of thermometers. More recently, in 1917, toxic jaundice from tetrachlorethane and trinitrotoluene (T.N.T.), or any other poisonous substance, was added on account of the mass poisoning from them among aeroplane and munition workers.

The reason why a symptom, toxic jaundice, and not poisoning by the substances in question, was asked for I will explain later. Still more recently, in 1920, epitheliomatous ulceration due to tar, pitch, bitumen, mineral oil or paraffin, or any compound, product or residue of any of these substances, and chrome ulceration, were added, and finally, on December 31st, 1924, poisoning by carbon bisulphide and aniline and chronic benzol poisoning became notifiable.

Soon after the 1925 Act was passed a medical man was appointed, fortunately, as Chief Inspector of Factories in the person of Dr., now Sir Arthur Whitelegge, K.C.B. I tremble to think what would have happened had the administration of section 25 remained in lay hands. Although I was not appointed the first medical inspector of factories until June, 1898, I can remember the publicity given to the prevalence of lead poisoning in the Potteries and White Lead Works, involving in some cases permanent blindness, convulsions and wrist drop, and to the concealment of cases of "phossy jaw" in the manufacture of lucifer matches. Indeed, it is an ill wind that blows nobody any good, and these terrible facts blew me into the Factory Department, to follow up the cases.

The statistics of notifiable diseases were in a state of chaos. I will let you into the secret of why the detailed figures commence in 1900 and not, as they might be expected to do, in 1896. I discovered that in the Division which included the most important white lead works the notification by the medical practitioner was treated as one case and the report upon it by the Certifying Surgeon as another, so that the number was doubled. I realised that unless the closely-scrutinised official figures were, like Cæsar's wife, above suspicion, there would be no end to the trouble. Consequently, stringent rules were drawn up for keeping them. No case of lead poisoning was included more than once in each year—second notifications being probably due to relapse or incomplete recovery from the first attack.

In form there is close similarity between this section dealing with industrial diseases and that in the Infectious Diseases (Notification) Act requiring the medical practitioner and the householder to notify the medical officer of health of every case of scarlet fever, diphtheria, &c. It is common knowledge that as regards the householder this enactment has been allowed to become a dead letter or, rather, to be held only as a sword of Damocles over his head, in the presence of flagrant exposure of himself or his child when suffering from infectious disease, because he is thereby credited with medical knowledge which cannot be expected of him. The case of the occupier of a factory is, perhaps, not quite on all fours with that of the householder because, employing people for his own profit on work in which exposure to poisonous substances is incidental, his duty to take precautions is apparent and, should injurious effects show themselves, his share in the responsibility for this must, within reason, be brought home to him. A defect in the section to my mind is that notification by the medical practitioner has to be made to a layman. It was a fortunate accident that Sir A. Whitelegge was a medical man. Industrial

diseases should be notified to the Senior Medical Inspector of Factories—or Chief Medical Inspector of Factories as he is in everything but the name—who is in the same plane as his informant and can enter into his mind. Fancy the medical practitioner having to notify infectious maladies to the town clerk !

Are there any other forms of poisoning or any other industrial diseases which should be added to the list ? The object of notification is not primarily to obtain statistics in the same way as devolves upon the Registrar General, but to obtain a clue to conditions over which the inspector can exercise control. Publicity, too, from the requirement to report cases is a salutary means of effecting, often enough, improvements in working conditions. I cannot say what strange new potent agents the chemical industries have in store for us, but at the moment I should say there would be advantage in including in the list chronic poisoning from hydrogen sulphide gas and dermatitis due to dust and liquids, expensive though the latter would prove to be.

Notification of industrial disease is more difficult than is notification of infectious disease. One difficulty the medical man is faced with is that, with the exception of anthrax, the poisonings he is expected to notify do not present the same unequivocal signs that acute infectious diseases like smallpox or scarlet fever do. No absolute definition of what constitutes industrial poisoning is possible, and each practitioner in reporting what he "believes" is one, must form his own standard in the same way as he forms his own standard of what constitutes ptomaine poisoning or fish poisoning. The point is that, owing to the slow onset of these insidious, industrial maladies, the patient passes through a stage of absorption which does not amount to poisoning and yet in which the stigmata of the particular compound—the blue lines on the gums from lead, the tremor from mercury, the cyanosis from aniline—are apparent. The medical practitioner has, therefore, in the first place, to make a differential diagnosis between the symptoms in lead poisoning, let us say, and the commonest everyday ailments—headache, anæmia, stomach-ache, rheumatism ; and, secondly, he has to make up his mind whether absorption is so advanced as to have exploded in acute or chronic poisoning. Common sense, however, dictates the desirability of fixing in some way the degree of severity of symptoms which should lead to notification, and few medical men probably would deny that, generally speaking, any symptoms necessitating absence from work and appeal to a doctor for treatment constitute sufficient grounds for notification.

But the mere presence of symptoms requiring medical assistance may not be all that is necessary to settle the question of notification. Take, for instance, T.N.T. poisoning. During the war it showed itself in the most protean way, first as a dermatitis, to which nearly all those coming into contact with it at first succumbed ; secondly, as a gastritis ; thirdly, in effects on the blood (formation of methæmaglobin, with consequent reduction of its oxygen-carrying power) ; fourthly, in specific destruction of the liver cells characterised

by jaundice and atrophy of the liver—a very grave condition ; and fifthly, in the rare form (always fatal) of aplastic anæmia, characterised by destruction of the red marrow of the bones with resulting great diminution in the number of red and white blood cells. These various symptoms are by no means always distinct from one another. With exception of the first, they are all to be described as T.N.T. poisoning, and they may merge one into the other—cyanosis may be present with gastritis or toxic jaundice; jaundice may be present with aplastic anæmia—they may be interchangeable or concomitant manifestations of the same poison. I have mentioned them all separately in order to insist that, for the purposes of statutory notification, all the forms are not equally important, although obviously the management of a factory ought to be aware of all cases. But when statutory notification has to be made, the medical practitioner and the occupier require a definite symptom to guide them. Publication of statistics of notification of tetrachlorethane poisoning or of T.N.T. poisoning during the war would have been unreliable as they would have simply referred to the number of workers coming into contact with tetrachlorethane in aeroplane works or T.N.T. workers in munition factories, of whom there were thousands and thousands, who sought medical treatment for any and every complaint. But figures published monthly in the *Labour Gazette* of *toxic jaundice* furnished a real indication of serious illness calling in each case for inquiry and report on observance of precautions in the particular process at which the affected person was employed. This was the procedure adopted. It reduced expense to the State, relieved the medical man and occupier of doubt as to when to notify, and saved endless worry and waste of time which would have resulted had a wider requirement been imposed. With the termination of the war the situation altered. Return to normal use of T.N.T. removed the fear of being snowed under with notifications, even if information was thus received of any one of the symptoms named, and so now opportunity for this has been given by the requirement to notify *aniline poisoning* signifying the symptom complex which the Germans describe as " Anilismus " and the French as "Anilisme."

PRINCIPAL RESULTS ACHIEVED.

Now, what are the principal results obtained from notification ? Look at this Chart of the cases and deaths of the 11 notifiable diseases and poisonings from the years 1900 to 1928 inclusive.

The Chart is given to impress the eye by the peaks, the precise number of the cases and deaths for each year appearing in Appendix I. Each of the small squares represents an inch, with sixteen cases in each. Black represents the cases, grey (*red* in the original diagram) the deaths. The four years 1915-1918—the years of the war—were coloured green in the original diagram and in the chart show grey.

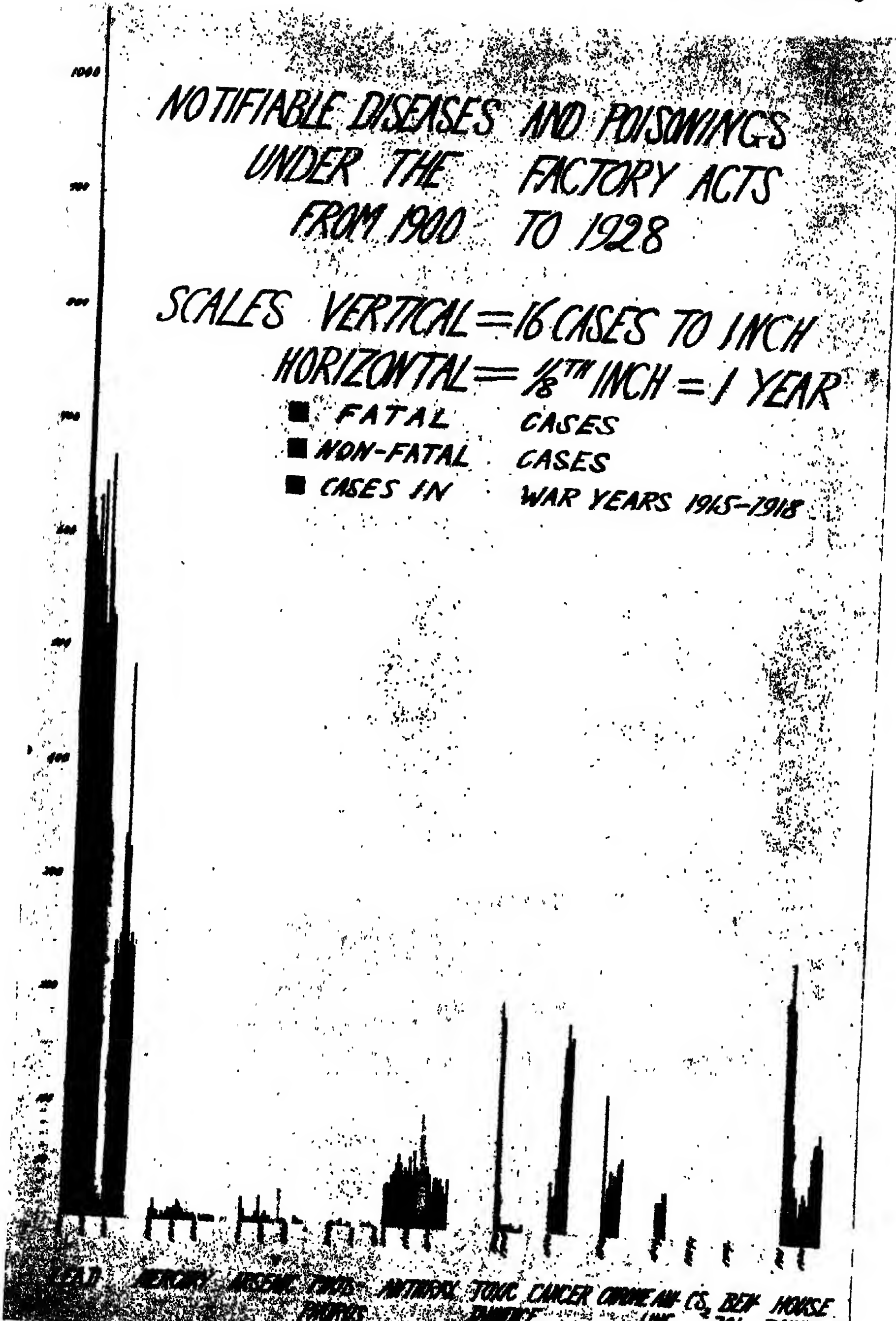
NOTIFIABLE DISEASES AND POISONINGS
UNDER THE FACTORY ACTS
FROM 1900 TO 1928
SCALES VERTICAL=16 CASES TO INCH
HORIZONTAL=1/8TH INCH=1 YEAR
FATAL CASES
NON-FATAL CASES
CASES IN WAR YEARS 1915-1918
LEAD
MERCURY
ARSENIC
PHOSPHORUS
ANTHRAX
TOXIC JAUNDICE
CANCER
CHROME
ANILINE
BENZOL
HOUSE PAINTING

Chart I.

You observe how lead poisoning dominates the picture and how negligible, comparatively speaking, appears poisoning by mercury, arsenic and, indeed, all the others, until you begin to read between the lines.

With *mercury poisoning*, for instance, as it occurs from inhalation of the fumes given off in the manufacture of clinical thermometers, and from the gradual absorption of the metal through the skin of the workman's hands, on which tiny droplets can be seen through a magnifying glass, for one case notified you will find in the shop perhaps twenty showing slight tremor, hesitation in speech, a flabby, indented tongue, coated teeth, slightly spongy gums and salivation pointing to absorption all the time of infinitesimal quantities of mercury. If you come up behind them and surprise the worker by a tap on the shoulder he will start as though he mistook you for a policeman—an indication of mercurial erythism. Similarly is it with the hatters' furriers, who inhale the floating particles of rabbits' fur which has been "carotted," *i.e.*, brushed with a solution of nitrate of mercury and thus becomes the vehicle for conveying the metal. Mercury poisoning, however, affords a magnificent example of invention—discovery of methods external to the workman removing the danger. The account we read of in Bernardino Ramazzini's book on the Diseases of Tradesmen, published in 1703, of mercurial poisoning in the Middle Ages shows it to have claimed far more victims than it does to-day. And why? Because the goldsmiths and silversmiths used an amalgam of mercury with gold and silver—watergilding—to decorate the ornaments they made and, to leave the precious metals behind, the mercury was volatilised by heat over a fire with evolution of toxic fumes. Mirrors, similarly, were backed with the same amalgam with terrible results to those who practised it in Fürth in Germany.

The introduction of electro-plating, largely due to Wright and the Elkingtons in the 'forties, and the nitrate of silver and ammonia process for the backing of mirrors, following on an experiment by J. von Liebig in 1835, have reduced mercury poisoning to very small proportions. And mass production of clinical thermometers by methods involving next to no handling and exposure to fumes will probably rob it still further of its terrors. Because mercurial poisoning is a very unpleasant form of poisoning.

Arsenic poisoning, although apparently so trivial in numbers, is industrially as interesting as is the criminal administration of its salts, although for quite other reasons. And the symptoms bear little resemblance to one another. Arsenical poisoning industrially occurs in two quite distinct forms: (1) from inhalation of, or contact with, the dust of salts of arsenic, showing itself in skin eruptions, especially where the dust, say, of emerald green or sheep dip "flies" and alights on folds of the skin, or on moist surfaces like the groin; and (2) from inhalation of arseniuretted hydrogen gas, showing itself most dramatically in the development of a coppery jaundice and hæmaturia owing to the fact that the gas is the most powerful destroyer of the red blood cells.

You can never get rid of the irritation set up by arsenical dust unless you can find a means external to the workman, clothe and protect them with respirators, etc., however completely you may try. Fortunately travelling belts, automatic packing machinery, combined with locally applied exhaust ventilation, have done the trick, as the reduction in the number of cases shows. The little peak in 1917 is due to cases arising from the manufacture of arsenic trichloride, which was used as a poison gas.

Phosphorus poisoning, the horrible redoubtable "phossy jaw," is now only of historical interest, since practically all the civilised countries (commencing with Denmark) have bound themselves to observe the terms of the Berne Convention of 1906 prohibiting the use of white phosphorus in the manufacture of lucifer matches.

Here a word will be apposite on the subject of prohibition. Many people—generally those who approach the subject on theoretical rather than practical grounds, or who have not themselves to handle, say, a dangerous material—take the view that prohibition is a confession of failure, like the extraction of a tooth, or amputation of a limb, to be adopted only when less severe methods will not save the situation as, *e.g.*, by Regulations. I have heard woolbrokers say, for instance, "We must bear with anthrax." I held this view myself once, and especially in the matter of the regulation of the use of phosphorus, before I realised the importance and the truth of my dictum that only an influence external to the workman brought to bear will remove the danger. Because when we thought the manufacture was safeguarded by stringent regulations as to locally applied exhaust ventilation, periodical dental examination, prohibition of employment after extraction of a tooth, etc., unfortunately some unforeseen loophole remained *e.g.*, the surreptitious visit to a dentist without saying anything about it and immediate return to work with subsequent development of necrosis of the jaw starting in that very tooth socket. And when the brilliant discovery of a substitute for white phosphorus in the sesquisulphide was made in France, the manufacturers themselves confessed they would rather accept prohibition than have to put their heads in the noose of almost impossible restrictions. And will it not be the same in regard to the prohibition of the use of white lead in the internal painting of buildings ?

Of all industrial maladies, *anthrax*, ridiculously small in the number of cases and deaths, when compared with measles, for example, holds out the greatest terror for the workman in those branches of industry in which it is prone to occur. (Chart II.) It always makes a frontal attack and is, in this respect, a splendid antagonist, so different from lead poisoning and fibroid phthisis—slinking and slow diseases, taking years to develop and incapacitate. For anthrax a fortnight is time enough for either a cure or a kill. And anthrax is no respecter of persons ; the very strong and robust succumb as readily as, if not more readily than, the weak. I have had many strange experiences with anthrax, and if I were superstitious, and had lived in the Middle Ages, I should

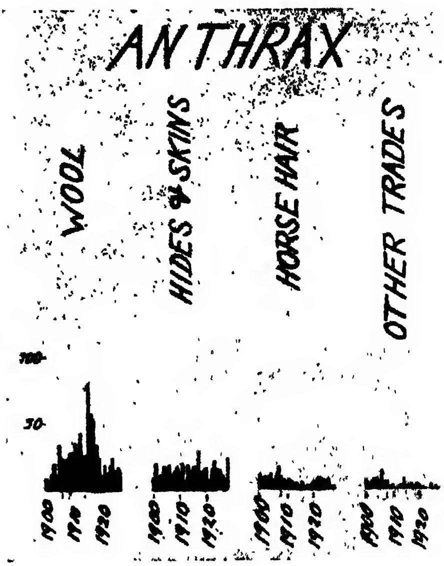

CHART II.

have burnt many a candle at the altar of St. Blaise, the patron saint of the woolcombers, as shown in a stained glass window in Oxford Cathedral, to protect me from the demon of anthrax. The disease is due to a bacillus which attacks hoofed animals—horses, goats, cattle, sheep and pigs—but not fur yielding animals, and from the fleece or hides of animals which have died of the disease in any part of the world—and in many parts it is far more prevalent than in this country—it may be conveyed to man. The blood of an animal dead of anthrax teems with bacilli which, as soon as they come into contact with the oxygen of the air, become converted into spores indestructible except by steam, boiling water or certain chemicals. Dr. J. H. Bell, of Bradford, was the first, in 1878, to prove the identity of the disease in animals and man. Anthrax is a world-wide question. Only two ways of mastering it are possible. One is to prevent animals contracting the disease by use of Pasteur's method of vaccination. Could this but be done it would be splendid, because it would protect both animals and men, but who imagines that inocculation of the herds of sheep and goats in Asia Minor, Persia, India, Thibet, or of the horses in Manchuria, or the cattle and buffaloes in Africa and the Straits Settlements and China, or the Alpaca sheep in Peru, is practicable?

The other way is disinfection of particularly dangerous classes of wool, and here magnificent work has been rendered, after some 130 experiments, in the working out of an influence external to the workman which not only promises but gives success, by G. Elmhirst Duckering, an Inspector of Factories and now the Director of the Government Wool Disinfection Station in Liverpool.

This station is the outcome of his own inventiveness, and has been built, including the machinery, from his own designs.

The method is simplicity itself, the principle underlying it being first a preliminary soaking of the wool in warm soap and water (presumably to convert the spores into bacilli and so render them more easily destructible) and then, when naked and freed from dirt and grease, passing the wool through a warm 2½ per cent. formaldehyde solution. This process has removed the nightmare of anthrax in Bradford which hung over the prosperous city for decades.

Horsehair can be similarly successfully treated. But properly spread out (in doing which danger is incurred) exposure to steam, preferably at a temperature of 225° F., is also effective.

A point to note also about the anthrax figures is that the number of cases in wool has not diminished in the same proportion as the number of deaths. Thus the mortality has steadily fallen from 29.6% in the quinquennial period 1899-1904 to 13.6% in that of 1920-1924—more than one-half. This is due partly to earlier diagnosis in the first critical days, but mainly to the treatment (without excision) by means of Sclavo's anti-anthrax serum combined with physiological rest—a method which Dr. Eurich has successfully practised at the Bradford Royal Infirmary, has been carried out also in the heavy woollen district of Dewsbury and is generally the approved method now in all large hospitals.

Toxic jaundice, with its sudden rise and equally remarkable fall and attendant high case mortality of about 33 per cent., is very remarkable. The fall is due to the fact that the *extraordinary* use of T.N.T. ceased after the war. But even if it had continued we should have been able to watch it with complacency, as its mode of entry into the system had been discovered and means, external largely to the worker, found to combat it by mechanical methods of filling shells. In 1903 Dr. Prosser White of Wigan and Dr. John Hay of Manchester, experimenting on themselves, showed how rapidly dinitrobenzol passed through the skin into the blood. In the early stages of the war this marked effect of the nitro and amido derivatives of benzene were rather lost sight of, in view of the obvious presence of much dust and fume, until the late Dr. Benjamin Moore, experimenting on himself with amatol (a compound of T.N.T. 20%, and ammonium nitrate 80%) showed how readily absorption through the skin could take place, as I had always maintained. Once this fact was recognised, introduction of mechanical means of filling shells in place of hand-filling quickly brought about a reduction.

Of *Epitheliomatous ulceration* (skin cancer) and *chrome ulceration* I will speak together, to bring out the striking difference between them. Both were made notifiable in 1920, and the figures in both stand rather high. But why in the case of chrome is there not a single death and why in that of epitheliomatous ulceration is the death rate so high (some 33 per cent.)? That is because coal tar and mineral oil and certain of their derivatives exert a carcinogenic effect

on the epithelial cells and chrome does not. No complete influence external to the workman can stop chrome ulceration, but watchfulness, and first-aid treatment will alleviate and hold it in check. Skin cancer on the other hand will be got rid of in the course of years to come by either the elimination in the tar and mineral oil of the not-yet-discovered carcinogenic substances, or by their neutralisation or destruction. It has, indeed, already been shown by Twort,[1] working in Manchester, that "the carcinogenic activity of an oil is much reduced or completely removed by extraction with sulphuric acid or by oxidation and by reduction." I believe the incidence (about 9 cases every month) of skin cancer among the 33,000 mule spinners in Lancashire of 25 years of age or over results, as my former colleague Dr. Henry[2] has gone a long way to prove, from the gradual change-over in the 'sixties and 'seventies from animal and vegetable to mineral oils, for the purposes of lubrication. A good deal can be read into the Chart III. or perhaps better with the Table of figures on which the Chart is constructed[3] :—

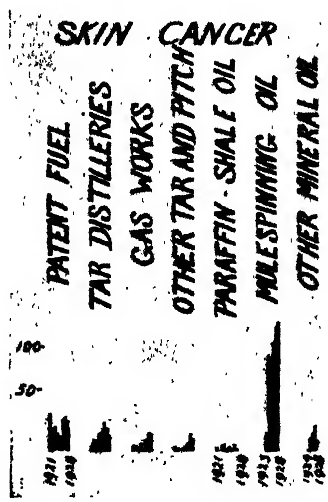

CHART III.

Agent.	Industry.	1920	1921	1922	1923	1924	1925	1926	1927	1928	Total.
Pitch and Tar	Patent Fuel ..	30	17	19^{1}	14^{1}	11	25^{5}	27	20	20	183^{5}
	Tar Distilling ..	4	9^{2}	6	14^{1}	15^{2}	23^{4}	18^{3}	14^{1}	23^{4}	126^{18}
	Gas Works ..	4^{1}	4	2^{1}	6^{1}	1^{2}	9^{2}	15^{9}	14^{5}	17^{13}	72^{34}
	Other	4	2	—	2	4^{1}	6	16^{2}	10^{3}	8^{2}	52^{9}
Paraffin	Shale Oil	3	—	5^{1}	6	2^{1}	4	2	6	2^{1}	30^{3}
Mineral Oil.	Mule Spinning	—	—	—	15^{1}	79^{17}	78^{35}	88^{20}	101^{31}	101^{36}	462^{140}
	Other	—	—	—	1	11^{1}	15^{11}	21^{15}	9^{9}	4^{3}	61^{39}

The principal figures relate to cases, the raised figures to deaths.

[1] C. C. Twort and J. D. Fulton, *Journ. of Path. and Bact.*, Vol. XXXII., 1929. p. 161.
[2] "Mule Spinners' Cancer: the time necessary for its production" by S. A. Henry, *Journ. of Hyg.*, Vol. XXVII, August, 1928.
[3] Int. Conf. on Cancer, London, 1928. Paper by J. C. Bridge and S. A. Henry.

The percentage of deaths to cases is low—not 3 per cent. among patent fuel workers, higher among the tar distillers, about 9 per cent., still higher among the cotton mule spinners, about 33 per cent., and over 47 per cent. among the retort house and pitch diggers in gas works. Why are there these differences ? The difference in carcinogenic potency in tar, pitch and mineral oil, as used in these industries, does not account for it. The reason, in my opinion, why the proportion of deaths to cases is so astonishingly high among tar distillers and gas workers as compared with patent fuel and shale oil workers is simply due to the fact that only a fraction of the cases is being reported in the former, whereas we hear of nearly all in the latter. The patent fuel and shale oil industries are concentrated in particular areas and so the malady has become known to workpeople and the medical profession, and this has led to prompter recourse to treatment *in the early stage of the disease.*

A word here may be apposite on counsels of perfection and the necessity of the employer doing everything. When you cannot bring any influence to bear external to the workman to remove the *causa causans* and can only then have recourse to remedial measures, you must not fix your standard too high or the result will be either failure altogether, or long delay in getting anything done. The salient feature about skin cancer is that not 5 per cent. begin to show the malady under 30 years of age. The average age among mule spinners who contract the disease is about 52 years. A further point, and this is a still more important point to be borne in mind in considering remedial measures, is that less than 3 per cent. manifest the disease in dangerous form under 20 years duration of employment, while the average duration is approximately 40 years. Periodic examination, therefore, should be limited to mule spinners aged 40 or over and with a duration of employment of 30 years. You will miss a few cases, but the great point is that you will have brought the number to be examined within reasonable limits, you will save expense and prevent evasion of the examination by men who will know that examination for them is a waste of time.

In compensation for deaths alone the cotton industry must anticipate paying £10,000 a year until they realise that by timely periodic examinations twice yearly (which would be enough for all practical purposes) this sum could be considerably reduced and life be spared.

A voluntary examination would be no use in this industry, where there are large numbers to be examined. Even when reduced to the lowest practicable number evasion would be easy, especially from a desire to conceal a condition situated, as it so often is, on the scrotum, with the result that the condition would become inoperable before knowledge of it would be gained. A voluntary examination was tried in South Wales among patent fuel workers over 40 years of age who had worked for more than 10 years. If failed badly in securing attendance, but it may have done good in enabling the workers to know that treatment was available. And treatment of skin cancer never was

so hopeful as it is to-day with radium showing itself as likely to be the remedy par excellence for the condition. A large gas works in London even now sends all its cases of pitch warts (to the number of over 20 every year) to the Radium Institute. The cases are cured by one treatment, and absence from work is limited to a day. There have been no recurrences. I hope the mule spinners, and all coming regularly into contact with tar and pitch, will demand their fair share of the radium which will be distributed to the various hospitals throughout the country before long.

The noticeable increase in the number of cases of chrome ulceration is due to the new process of electrolytic deposition of chrome on metal—chromium plating. Here the hydrogen bubbles, bursting at the surface of the bath, allow a very finely divided spray of chromic acid to escape into the air which is only partially controllable by locally applied exhaust ventilation.

Aniline poisoning, as has been said, is intended to cover poisoning from any nitro and amido derivative which penetrates the skin directly by dissolving out the natural grease and combining with the hæmoglobin to form methæmoglobin. The cases notified are but samples of several others in which the ashen grey colouration of the lips and tips of the ears is present without the worker being aware that anything is peculiar about his complexion. A drop of his blood, however, when the lobe of his ear is pricked with a needle is chocolate coloured. Truly the blood can stand a great deal! Hot summer days prove too much for it, and I have known factories manufacturing these compounds idle because all the men were ill. If work has to be done at all in the summer it must be done before the sun is up or after it is down.

Carbon bisulphide only became notifiable in 1920. It is an interesting instance of a poison the toxicity of which was notorious forty years, and then was satisfactorily dealt with by regulations.

In the early days of vulcanisation of rubber by the "Parkes" or "cold cure" process—dipping the articles into a solution of sulphur chloride dissolved in carbon bisulphide—all those so engaged suffered from its harmful effects; and very serious they were—headache, paralysis, especially of the leg muscles, mental hebetude, impotence, acute mania, and not infrequently amblyopia. Laudenheimer in 1899[1] published the histories of fifty cases of mania in rubber workers. Of the first three cases described in Great Britain by A. Bruce[2] two suffered from amblyopia. Nettleship[3] described a similar case in 1885. So prominent, indeed, did this symptom become that the Ophthalmological

[1] *Die Schwefelkohlenstoffvergiftungen der Gummi-Arbeiter unter besonderer Berücksichtigung der psychischen und nervösen Störungen und der Gewerbehygiene.* Leipzig, 1899.

[2] "Chronic Poisoning by Carbon Bisulphide," *Trans. Med.-Chir. Soc. Edin.*, 1883-84, pp. 145-153.

[3] "A Case of Amblyopia with Partial Optic Atrophy and General Nervous Depression and Emaciation caused by the Vapour of Carbon Bisulphide: Partial Recovery," *Trans. Ophthal Soc. United Kingdom*, 1885.

Society appointed a committee to investigate the action of the vapour of carbon bisulphide and sulphur chloride on the sight and health. This committee tabulated twenty-four cases, in five of which there was little or no improvement even after giving up the work. Many other references could be given. A story was current in Salford about 1899 of a maniacal rubber worker rushing about the factory brandishing a carving knife. Imagine the effect of this on two hundred factory girls! The Committee on certain Miscellaneous Dangerous Trades[1] which reported in 1896 recommended special rules, the principal of which were: (1) downward exhaust ventilation, the vapour being more than twice as heavy as air; (2) enclosed machines for waterproofing cloth; (3) no spells of work to last more than two and a half hours without a break of one and a half hours; (4) monthly medical examination of the workers by the certifying surgeon. So successful were the special rules drawn up on these lines that little more was heard of CS_2 until new uses were found for it, and especially in the artificial silk industry by the viscose process. Stress has been laid on the severity of the symptoms in the absence of scrupulous attention to detail in precautionary measures. It is disquieting to hear of a case of amblyopia contracted in an artificial silk factory, and to read, in a recent report of the Chief Inspector of Factories, of a severe case involving "headache, vomiting, delirium, loss of muscular power, and almost complete loss of sensation." The trouble occurs in what is called the "churn" room, where the alkali-cellulose is treated with carbon bisulphide in a hermetically-sealed mixer or churn. After the process is stopped at the desired point a negative pressure is maintained in order to remove the vapour. The workman, however, is then compelled to put his head inside the churn to remove the orange-coloured sticky mass. Few workers in the churn room are free from the slighter symptoms, attributable to carbon bisulphide; nor is this surprising, seeing that 0.3 part per 10,000 of air will produce them. Efforts should be made to find a substitute for carbon bisulphide. This, however, is not the only risk run in the artificial silk industry. Extreme discomfort is caused by the sharp pain, photophobia, and conjunctivitis set up by traces of sulphuretted hydrogen gas generated at the spinning troughs. The gas may not be present in a proportion greater than 1 part in 10,000 of air, but such small amounts are just those to cause the distressing symptoms mentioned. I recall that in the change over from the manufacture of yellow phosphorus to the sesquisulphide a manager of a works confessed that his life was made miserable to him by incessant conjunctivitis until he had placed every bin for the storage of the stuff under a negative pressure. Another manager of a chemical works in those days was visiting weekly (without improvement) an ophthalmic surgeon for chronic conjunctivitis limited to one eye. This eye it was that he applied periodically to the peep-hole of a vat, otherwise closed in, in which H_2S gas was given off. The artificial

[1] C. 8149.

silk industry starts with a tremendous advantage in the experience already gained as to the effects of the toxic agents used or evolved. The day in, day out exposure to them by the workpeople should never be forgotten.

Of chronic benzol poisoning only one solitary case has been notified. The statutory requirement, however, was asked for because of deaths among men engaged in the waterproofing of fabric with rubber dissolved, not in naphtha, the usual solvent, but in benzol, because naphtha was required for other purposes during the war. And they had died after having inhaled the very diluted vapour given off after about three months' exposure with a remarkable train of symptoms due to the destruction principally of the white blood cells, and, to some extent also, of the red. Now that attention has been called to the risk there will be trouble if benzol continues to be used instead of less harmful substances, such as toluol and xylol, as a solvent or thinner for cellulose sprays in motor car and other painting. All good cellulose spray manufacturers should on principle reject benzol as an ingredient.

NOTES ON BOOKS.

THE ARTS AND CRAFTS YEAR BOOK AND DIRECTORY, 1929. London: Hutchinson. 12s. 6*d*.

Union is strength: one feels that even a book which brings together the names and descriptions of artists, craftsmen and their works is an accession of useful force. Creative people are difficult to organise, but the difficulty must be overcome; they themselves are not averse from an improvement in their lot.

In their long struggle against a complacent philistinism the arts and crafts in England have gained more ground than may be commonly recognised. Their ever firmer alliance with industry is having important consequences. Goodness knows how much industry needed their saving inspiration—needed and *needs*, one should say. And artists generally are still in want of some of that prestige which enables factory hands to claim a minimum of security as essential for adequate production. No-one to-day believes that starvation and overwork are the right conditions for industrial workers; it is even beginning to be felt that they may be the wrong conditions for artists and craftsmen. The sooner these are recognised as having their niche in industry the more quickly will they be enjoying three meals a day.

To the all-important, strategic, central position of the Royal Society of Arts the editors devote nearly eighty pages of their book.

How the British Institute of Industrial Art is succeeding in its purpose of "raising the standard of design and craftsmanship" was illustrated at the recent British Industries Fair at the White City, where the section organised by the B.I.I.A. stood out so remarkably from the rest of the Exhibition.

Like the B.I.I.A., the Rural Industries Bureau has come into being since the war, and has already proved its worth.

The Arts and Crafts Exhibition Society, founded in 1888, held its last show at Burlington House last autumn. Many of the exhibits were remarkably fine.

About these and other organisations Messrs. Hutchinson's handbook gives much pertinent information. It should find its way on to the shelves of all who have the real interests of British art and industry at heart.

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FRIDAY, SEPTEMBER 6th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C (2.)

PROCEEDINGS OF THE SOCIETY.

SHAW LECTURES

THIRTY YEARS' EXPERIENCE OF INDUSTRIAL MALADIES.

By SIR THOMAS MORISON LEGGE, C.B.E., M.D.,
late H.M. Senior Medical Inspector of Factories.

II.

LEAD POISONING.

(Delivered February, 1929.)

I have left lead poisoning to the last as being the most important form of industrial poisoning and the one about which there is most to say. The essential points to remember about it are: (1) that industrially the compounds alone are poisonous, the handling of metallic lead and its alloys being harmless in the absence of dust; (2) that two milligrams, i.e., 1/32nd of a grain, absorbed daily, will in time undermine the constitution and set up chronic lead poisoning with changes in the kidneys and arteries which will shorten life; (3) that it is—again I am referring to industrial lead poisoning in this country—entirely due to inhalation of leady dust or fume and not at all to handling; (4) that absorption takes place far more generally through the lungs than through the alimentary canal; and (5) that in its prevention we have had the most brilliant successes from the application of the principle on which I have laid so much stress, namely, an influence brought to bear external to the workman over which he can exercise no control, as is patent from the marvellous drop generally, and in white lead works, china and earthenware work and paint and colour works particularly. In contrast, failure and disappointment have resulted where that principle has not been successfully or completely applied, as in lead smelting works, electrical accumulator factories, and in the tragedy of the house-painting industry.

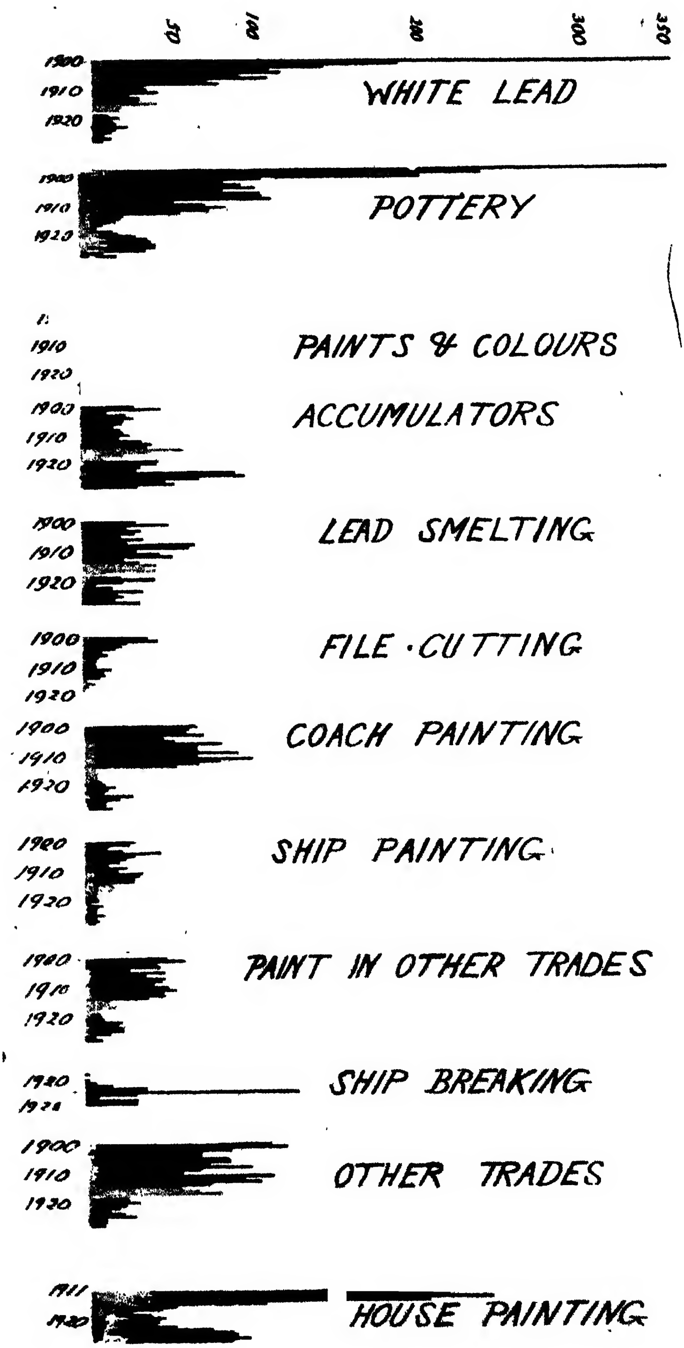
WHITE LEAD
POTTERY
PAINTS & COLOURS
ACCUMULATORS
LEAD SMELTING
FILE-CUTTING
COACH PAINTING
SHIP PAINTING
PAINT IN OTHER TRADES
SHIP BREAKING
OTHER TRADES
HOUSE PAINTING

CHART IV.

All this and much more is demonstrated in Chart IV, which splits up the great block of lead-poisoning cases shown in Chart I into their main constituent industries on the same scale and over the same number of years. What has brought about the fall in white lead works? The Home Office Regulations (for which I was responsible, I remember, in 1899) are stringent enough as to fan ventilation, stoving, weekly medical examination, and welfare provision. But far more potent than these was the praiseworthy discovery within the trade of the much greater affinity of carbonate of lead for oil than for water. And the great drop is mainly due to the invention of a machine allowing pulp white lead, i.e., a thick suspension of the carbonate in water, to come in at one end to be intimately mixed with oil and to emerge at the other as paint ready for the market.

In pottery manufacture removal of dust by locally-applied exhaust ventilation has accomplished much in the direction of diminution in the poisoning, but the *coup de grace* was delivered by the discovery in the Government Laboratory by its Principal, Sir Edward Thorpe, that, in contrast to raw lead (red lead, white lead) which up to 1890 had been used almost universally for the glaze and is soluble in dilute acids, if the raw lead is mixed with siliceous material this solubility can be greatly reduced. Moreover, the insolubility of the lead depends not upon any one oxide or group of oxides, but on the maintenance of a certain proportion between the whole of the basic oxides on the one hand and the whole of the acidic oxides on the other. It comes to this, then, that you can use as much lead as you did before when using the dangerous raw lead, but if you mix it in certain definite calculated proportions with silica and frit it, it will be comparatively harmless. This is called "low solubility" glaze.

In the manufacture of paints and colours, by which is meant the grinding up of colours into a fine poweder under edge runners, with necessarily the production of much dust, the improvement has been mainly due to locally applied exhaust ventilation. Lead smelting, and the manufacture of accumulators, show practically no improvement, and like an honest surgeon, I wish to describe the failures as well as the successes, as from the failures, perhaps, most is to be learnt. Evidently in these industries no method of cutting out the personal element has been made universally applicable. This is true, and the enormous amount of handling and consequent exposure to slight amounts of dust of the lead compounds used are greater almost than can be dealt with by methods of dust removal and welfare unaided. I have introduced the word "almost" into the above sentence because of the meticulous care and attention required (hardly to be expected of human nature in general) of one kind or another, i.e., where the employer does *everything* he can rid himself of the risk.

The actual figures for all the industries (and of others not included) are given in the appendix. The scale is the same as in Chart I. Note that white lead is hoisted up all through a small square too high and that the figures for pottery go back to 1899.

But at what a cost compared to the method of substitution or automatic methods! The accumulator industry is that in which, with the exception of house-painting, at the present time, more cases of poisoning are occurring than in any other. In, perhaps, the largest factory, where everything nearly had been done which human ingenuity could suggest, even to use for a part of the output of pasting machinery, among about 1,000 persons coming into contact with lead compounds 11 cases of lead poisoning occurred in 1926 and 18 in 1927. What more could be done, except to engage a whole-time works surgeon to study the men and the work, to make use of every means at the disposal of science in determining the lead contact of the air in the workrooms, in determining also the day-to-day changes brought about by lead in the red blood cells, and so to find out where the danger was greatest? I leave it to you to say whether it was cause and effect, but this firm had no case in 1928, and none has been reported up to the present (July, 1929). Now that factory I visited thirty years ago on complaint by the District Inspector as to the bad conditions, and it is the only factory in which the escape of dust has been so great as to give me the sweet taste of a salt of lead in my mouth all the time I was there.

The manufacture of electrical accumulators is, I have noticed, more susceptible to anything creating bad conditions than any other. I mean, if manufacture is commenced before the fans, etc., are installed, a crop of cases will occur. If a disturbance in the industry occurs, as it did with the demand for batteries for wireless and for motor cars in 1922-24, there will be a peak. If a machine for the pasting of accumulator plates were made universally applicable, it would halve the number of cases in the industry at once.

The disappearance of lead poisoning in file-cutting, again, is due to the disappearance of the hand-file cutter, the work being done by machinery, largely now on a spelter bed instead of the lead bed which caused all the trouble.

Now while that marvellous drop was going on between 1900 and 1910 in the manipulation of white lead, the number of cases from its use in coach and ship-painting, and in house-painting, was going up noticeably. That arose from the fact that it was impossible to control by a fan, or by any means independent of the workman, the dust generated in rubbing down the painted surface with sandpaper. The fall in incidence of poisoning in coach painting since the war is due to the absence of white lead in the paint, largely owing to the enormous development of spray painting of motor cars, etc. The manufacturers are too sensible, and are too frightened, to think of using lead compounds as an ingredient of cellulose sprays. In house painting, where the rise again after the war is noticeable, the failure of the cases to go on rising to the level they reached before the war is due, in my opinion, to various causes, chief of which are: (1) continued discontinuance of the use of white lead in the internal painting of buildings owing to other paints—those on a

zinc base and titanium oxide giving a much prettier effect; (2) the fact that the painters who have taken on the work since the war have not accumulated enough lead yet for it to explode as lead poisoning. I do not think it has anything to do with that Act passed in 1927 called the Lead Paints (Protection against Poisoning) Act, which did precisely the opposite of what had been approved in Geneva in 1921 by ninety delegates, representing employers, workpeople and governments from thirty-three countries, none voting against and only one abstaining. Ratification, I hope, will now be made as in the case of the Eight Hours' Day. Why should the house-painters continue to run the risk of poisoning? Where highly-poisonous ingredients are used in industry, a *laissez faire* policy, is not enough. To ask the house-painter who uses white lead to do no dry rubbing down is to ask him (1) to lose money, as it takes longer and is more trouble to use wet sandpaper; (2) he must have a pail; (3) he must have water in it; (4) he must have sponges; (5) he must keep his hands wet and so undergo discomfort and run the risk of eczema; and (6) he must have the will to do all these things. Recently, when staying in France, I experienced unfeigned satisfaction that, at any rate, house-painting had been made safe for the worker there. I was struck, too, by the much more beautiful effects and brighter colours they aimed at and secured in the painting of their buildings with none of the dirty, drab colour, characteristic of white lead after a short exposure to the atmosphere.

Sir Thomas Oliver could not now say, as he did in his Shaw Lecture in 1907, that the French Legislature, despite the agitation in favour of it, always failed to give effect to prohibition.

I have often said that wrong conclusions are sure to be made from statistics of lead poisoning unless you know all about them. For instance, anyone with knowledge could tell at a glance at them that between 1914 and 1919 a cataclysm had occurred to upset them in the way they were upset. And, indeed, you can read the history of the war from the figures. Why should there have been an enormous drop in all the lead industries, except lead smelting and electrical accumulator manufacture? Because not less lead was smelted, but only that its use was diverted to the making of shrapnel and bullets, and accumulators were in increased demand for motor cars, submarines and wireless. Further, why is the proportion of deaths to cases relatively so much higher in the pottery industry and house painting than in the others? Is it that they are so much more dangerous? No; it is because, once taken up, work in those two industries continues longer than in the others, and the workers become the victims of chronic lead poisoning, so that under the beneficial provisions of the Workmen's Compensation Act, which came into force in 1906, the relatives of a deceased lead worker can justly receive compensation when any sequela of saturnism, such as Bright's disease or cerebral apoplexy, appears on the death certificate.

Further, do the figures help to solve the vexed question, so frequently asked,

Are women more susceptible to lead poisoning than men ? Returns of occupiers do not lend themselves readily to a solution of this problem, as no census is given of the number of persons exposed to risk in the different processes. This, however, was done voluntarily over a number of years in the china and earthenware industry, and enabled an attack rate per thousand employed to be made out. Regularly, in the different branches where men and women were employed, the figures showed females to be attacked about twice as frequently as the males. There are many pitfalls, however, as, for example, the possible greater danger in processes in which women predominate or the average shorter duration of their employment. Most cases of lead colic occur within the first two years of employment. Still, I consider women to be more susceptible to effects of lead poisoning than men. The proportion of women notified as suffering from lead poisoning in whom headache is a symptom is more than twice that among the men, and the brain symptoms (encephalopathy, the severest form which lead poisoning can assume) is also greater. On the other hand, paralysis (wrist drop) is more frequent in men, but that is only evidence that their duration of employment is much the longer, as wrist drop is always a late symptom. There is, at all events, no doubt as to the baleful influence of lead compounds on the uterine functions. Disorders of menstruation are common, the tendency to miscarriage in some lead workers is so pronounced that only after ceasing work in lead can full term be reached. When diachylon is taken as an abortifacient the patient usually swims for her life. I mention these facts because a section of well-intentioned persons is bent on an endeavour to remove every restriction on women's work. I personally hold the view that the only restriction which should constitute a bar is employment directly interfering with the function of maternity, and employment in lead is the only one I know. I would prefer to leave it to women to say how far moral dangers should lead to restrictions. Bearing this in mind, a Recommendation of the General Conference of the International Labour Organisation, held at Washington in 1919, urged that " In view of the dangers involved to the function of maternity, and to the physical development of women, and young persons under the age of 18 years, they should be excluded from employment in the following processes :—

(*a*) In furnace work in the reduction of zinc or lead ores.

(*b*) In the manipulation, treatment, or reduction of ashes containing lead, and in the desilverising of lead.

(*c*) In melting lead or old zinc on a large scale.

(*d*) In the manufacture of solder or alloys containing more than 10 per cent. of lead.

(*e*) In the manufacture of litharge, massicot, red lead, white lead, orange lead, or sulphate, chromate or silicate (frit) of lead.

(*f*) In mixing and pasting in the manufacture or repair of electric accumulators."

It was further recommended "That the employment of women and young persons under the age of 18 years in processes involving the use of lead compounds be permitted only subject to the following conditions:—

(*a*) Locally applied exhaust ventilation, so as to remove dust and fumes at the point of origin.

(*b*) Cleanliness of tools and workrooms.

(*c*) Notification to Government authorities of all cases of lead poisoning, and compensation therefor.

(*d*) Periodic medical examination of the persons employed in such processes.

(*e*) Provision of sufficient and suitable cloakroom, washing, and mess room accommodation, and of special protective clothing.

(*f*) Prohibition of bringing food or drink into workrooms."

These points have been embodied in the "Women and Young Persons (Employment in Lead Processes) Act, 1920."

Then a closely allied question is, Does lead poisoning in the father affect his offspring to the same extent as does lead poisoning in the mother? In my view it is all a matter of degree of the poisoning. Under the conditions of its general use in this country now, with the possible exception of house-painters (among whom cases are twice as severe as factory cases and the amount of chronic poisoning four times as great), there is little evidence that a male lead worker is less likely to beget children, or that his children are more likely to be unhealthy than those of men working in any other industrial process. In the absence of any precautions whatever, the effect on the offspring, even in the case of male lead workers, may well be evident, as was shown years ago in the manufacture of pottery as a home industry in Hungary by Chyzer, and again in some other instances cited by Dr. Alice Hamilton in her book, *Industrial Poisons in the United States*. Account has to be taken of so many variables in trying to decide this question as to make a definite conclusion upon it very difficult.

Close analysis made by me of the reports by certifying surgeons on 10,923 cases of lead poisoning notified and reported on during the past thirty years has brought out certain essential facts. Thus, comparison can be made of the cases reported in four five-yearly periods in respect of (1) increase or decrease in the number recorded; (2) severity of attack; (3) number of attack, that is, whether it was the first, second, third or chronic; (4) main symptoms. It brings out also the progress shown in prevention.

Taking the figures as a whole—they are printed in full in Appendix II and some points are shown diagrammatically in Chart V—the most noticeable features are reduction in severity and in the number of chronic cases, and consequential increase in the moderate and slight attacks.

The total number of symptoms greatly exceeds the number of cases, but this does not affect the correctness of the estimate of each one as a proportion

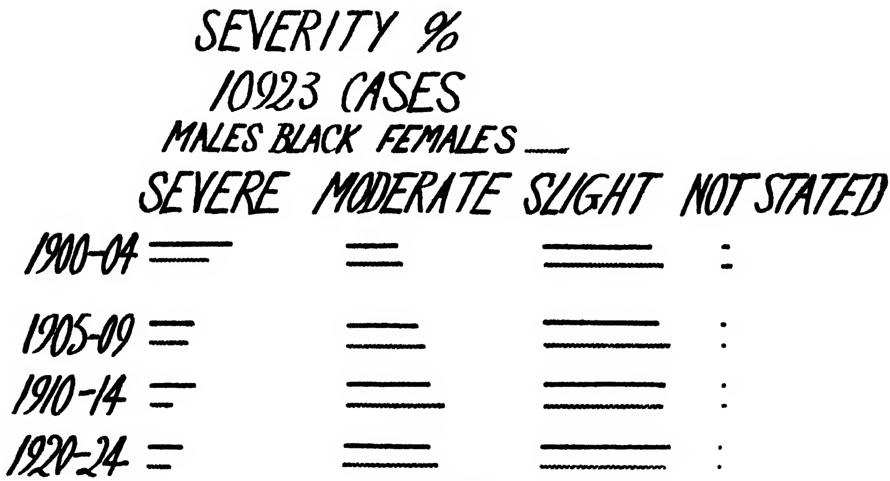

CHART V.

on the total number reported. Nearly always a combination of symptoms—colic, anæmia, headache, etc.—is described as present.

Reduction in the severe cerebral symptoms is very important, as their occurrence must be regarded as due to inhalation of lead dust, or fume, in excessive amount, and indicates failure, therefore, at some point or other in precautionary measures. Happily these cases of enceptholopathy have diminished more than any others, as the chart shows. It was the cases of convulsions and blindness in quite young girls, thirty years ago, which agitated so much the public mind.

Discussion has recently been raised over the question—Is there a weakening of the muscles from chronic lead absorption which can serve as a diagnostic

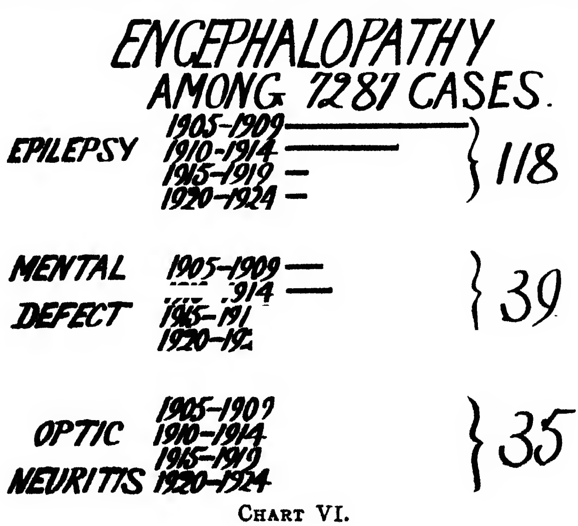

CHART VI.

sign? I believe there is. In this connection it is important to distinguish "weakness" from "palsy," which is a synonym for paralysis. The palsy commonly called "wrist drop," or paralysis of the extensors of the forearm, among house-painters, and other forms of paralysis such as that affecting the small muscles of the hand, where tight gripping of a tool or article has to be practised for hours, day in, day out, as in hand-file cutting and metal capsule polishing, are fairly frequent. But you do not find them, although the same gripping may be necessary in other industries, when no lead is present. So it is not the result of fatigue. The view of the opponents of the idea of "weakness" as a diagnostic sign is that if there is any weakness of the muscles in lead workers it has nothing to do with lead *per se*, but is a consequence of the general weakness of the whole organism and of the whole muscular system. Instruments for testing the muscular power, according as they are manipulated by those who support the contention that "weakness" is a symptom, are usually positive, and by those who deny it, negative.

As bearing on the question whether lead poisoning, apart from paralysis complete or partial, especially of the extensor muscles of the forearm and of the right forearm in preference to the left, also "weakened" them, I analysed 6,499 reports on notified cases by Certifying Surgeons on this point between the years 1910 and 1927. The Surgeons, on the forms they had to fill in, were asked to distinguish between "paralysis" and "weakness." The request was made because there was difficulty in deciding whether such terms as "weakness of arms," "muscular weakness," and "loss of power in the arms," should be interpreted as incipient paralysis or not.

In the 6,499 cases were 680 cases (6.2 per cent.) of paralysis and 603 cases (5.5 per cent.) of weakness. They were distributed as follows:—

Muscles Affected.		Paralysis.		Weakness.	
		Cases	Per Cent.	Cases	Per cent.
Arms and legs	Complete ...	11	1.6		
	Partial	40	5.9	88	14.6
Legs ...	Complete ...	4	0.6		
	Partial ...	20	2.9	52	8.6
Both forearms	Complete ...	227	33.4		
	Partial	175	25.7	358	59.4
Right forearm	Complete ...	63	9.3		
	Partial	36	5.3	55	9.1
Left forearm	Complete ...	27	4.2		
	Partial	17	2.3	35	5.8
Fingers		41	6.0	12	2.0
Other (Deltoid, etc.)		19	2 8	3	0.5
Total		680	100	603	100

The point which interests most is the relative degree to which the extensor muscles of the right and left forearm are affected. Not only in regard to paralysis, both complete and partial, is the right forearm shown to be con-

siderably more affected than the left, but it is so also in regard to "weakness." This suggests strongly that there is something more than mere general debility induced by lead which brings this about, and that this something is the action of lead itself, probably on the muscular tissue.

This relationship is shown diagrammatically in the following chart. It also shows what a remarkable feature wrist drop, from the selective toxic action of lead on the musculo-spiral nerve, is.

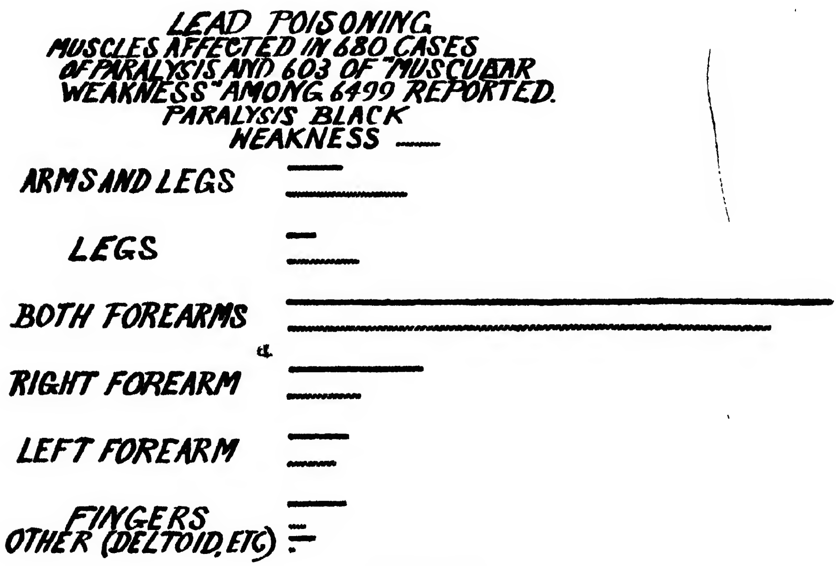

CHART VII.

Indeed, I regard the testing of the strength of grasp and of the strength of the fingers and wrists as the most useful single test there is for detecting chronic lead absorption rapidly, as so often has to be done on factory premises, among a large group of workmen.

In the many doubtful cases of lead poisoning which present themselves, especially of early lead poisoning, a diagnosis must be made from the whole picture and not by a mere adherence to the presence or absence of one or another symptom. The German toxicologists consider the cardinal signs to be blue line, typical facies (cachexia), punctate basophilia in the red blood cells, and the finding of hæmatoporphyrin in the urine. To do this properly, however, requires more complete education of the general medical practitioner in the diagnosis of industrial diseases than he now receives.

Unfortunately, lead poisoning seems to be able to raise its hydra head in all manner of baffling ways. When we imagine we have conquered it, a new form appears which defies our ability to find the needful influence external to the workman to prevent ill effects. Thus you see from Chart I how cases

in shipbreaking began to appear in 1910, and by 1915, in this quite small occupation, more than a hundred cases were notified. This is due to volatilisation of lead from the paint and red lead backing on the armour-plating by the great heat of an oxy-acetylene blow-pipe flame used for cutting purposes. Experiments carried out under the direction of the Principal Chemist of the Government Laboratory showed that the amount of lead present in 10 cubic metres of air at the breathing level was 49 milligrams, that is, 25 times as great as the daily dose (2 milligrams), which I regard as the minimum which may cause chronic plumbism if inhaled daily. The wearing of a breathing apparatus, i.e., a face-piece with long tubing attached by means of which a person using it breathes ordinary air drawn in through the free end placed several feet distant, is the only complete protection. And what is one to think or say about the great ethyl petrol stunt? That came over from the United States in more senses than one, and to explode it the time and attention of eleven experts was taken up from April 2nd to July 16th, 1928, in coming to the unanimous conclusion "that there were no reasons for prohibiting the use of ethyl petrol." Not a single case of lead poisoning from the use of this substance had or has been reported in this country, but pressure of some sort or other led the House of Lords to move for the appointment of a Committee of Investigation, the same House having shut their eyes to the fact that more cases of lead poisoning were occurring in the house-painting industry than in any other industry.

Lead poisoning can only be prevented; it cannot be cured. Symptoms, though, can be treated and relieved. While saying this I am not unmindful of the undoubted progress that has been made recently in our knowledge of how lead acts when absorbed into the system by Drs. Aub, Fairhall, Minot and Reznikoff, working in the Harvard School of Public Health.* Their view is—and they adduce much in support of it—that lead is probably transported in the blood stream in the form of colloidal lead phosphate, and deposited in the bone tissue as tertiary lead phosphate. This is sensitive to changes in acidity and accounts for the fact that the bulk of the deposited lead is in the bone tissue. They suggest a new line of treatment (for which their book must be consulted) based on the view "that when symptoms of lead intoxication are evident (toxic episodes) it is wise to immobilise lead by impeding its liberation from the bones," and this can best be done by a diet containing much calcium in the form of milk and calcium lactate. Attempt at "deleading" should not be begun until acute symptoms have entirely subsided. To do this either acid should be administered with a diet containing very little calcium, or alkalies should be given alone.

Their experiments prove that lead enters the organism most rapidly by the respiratory tract. Hence the exposure to be most guarded against is inhalation of lead or its compounds in the finely-divided state.

* *Lead Poisoning.* Williams & Wilkins Co., Baltimore, 1926.

PPENDIX* I.

LEAD POISONING.

Industry.	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
1. Smelting of Metals	34^{1}	54^{3}	28	37^{2}	33^{1}	24^{1}	38^{1}	28^{2}	70^{2}	66^{5}	34^{5}	48^{3}	56^{7}	26^{3}	36^{3}
2. Plumbing and Soldering ...	9	23	23^{1}	26	21^{3}	24^{2}	16^{4}	20^{2}	27	28	25^{1}	37^{2}	35^{5}	34^{1}	25^{2}
3. Shipbreaking	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
4. Printing	18^{2}	23^{1}	19	13^{2}	15	19^{4}	16^{2}	26^{3}	30^{2}	21^{1}	33^{4}	32^{2}	37	21^{1}	23^{1}
5. Tinning of Metals	5	10	11	14	10	14^{1}	18^{1}	25	10	22	17	13	15^{1}	9	10
6. Other contact with molten lead	30^{1}	25	24	23	20	24	24^{1}	19	28	19^{2}	17^{1}	37^{4}	21	28	21^{2}
7. White Lead	358^{6}	189^{7}	143^{1}	109^{2}	116^{2}	90	108^{7}	71	79^{3}	32^{2}	34^{1}	41^{2}	23	29^{2}	29^{1}
Red Lead	19	14	13	6	11	10	6	7	12	10	10	13^{1}	3	7	6
8. Pottery	210^{8}	113^{5}	89^{4}	100^{3}	109^{4}	89^{3}	112^{4}	113^{9}	119^{12}	59^{5}	78^{11}	93^{6}	81^{15}	63^{11}	28^{6}
9. Vitreous Enamelling	11	9	3^{1}	4	3	2	4	6	7	7	17	19^{1}	5	9	11
10. Electric Accumulators ...	33	49^{1}	16^{1}	28	33	27^{1}	26	21	25^{1}	27^{2}	31	24^{1}	38^{1}	44	41
11. Paints and Colours	56^{1}	56	46	39^{1}	32^{1}	57^{1}	37	35^{1}	25	39^{2}	17^{1}	21	19	22^{1}	21
12. Indiarubber	1	1	2	1	1	4	2	1	2	4	3	8	4	2	9
13. Coach Building	70^{5}	65^{4}	63^{1}	74^{5}	49^{4}	56^{3}	85^{7}	70^{3}	70^{3}	95^{6}	70^{6}	104^{5}	84^{7}	71^{2}	57^{4}
14. Shipbuilding	32^{2}	28^{1}	15^{1}	24^{1}	48	32^{2}	26^{1}	22^{1}	15	27^{1}	21^{2}	36^{6}	34^{2}	31^{1}	31^{5}
15. Paints used in other Industries	50^{5}	61	44^{1}	46^{1}	27^{3}	49^{2}	37^{3}	49^{2}	47^{1}	42	51^{3}	56^{1}	48^{3}	49^{3}	39
16. Other Industries...	122^{7}	143^{12}	90^{3}	70^{2}	69^{8}	71^{2}	77^{2}	65^{3}	80^{8}	55^{4}	47^{3}	87^{3}	84^{3}	90^{2}	56^{4}
TOTAL	1058^{38}	863^{34}	629^{14}	614^{19}	597^{26}	592^{23}	632^{33}	578^{26}	646^{32}	553^{30}	505^{38}	669^{37}	587^{44}	535^{27}	445^{28}
House Painters												212^{35}	217^{37}	248^{31}	207^{35}
House Painters and House Plumbers (together)	119^{42}	169^{41}	179^{32}	201^{39}	227^{39}	163^{29}	181^{36}	174^{39}	239^{44}	241^{47}	232^{37}				
House Plumbers												51^{13}	39^{10}	43^{6}	34^{4}

* The raised figures refer to deaths.

Industry.	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
1. Smelting of Metals	47^{1}	39^{4}	46^{1}	15^{1}	24^{5}	45^{3}	25^{4}	9^{2}	19^{2}	38^{1}	22	26^{1}	21^{1}	36^{2}
2. Plumbing and Soldering ...	17^{2}	12	34	21^{2}	9	3^{1}	7	8	8^{1}	6	7	7^{3}	11^{1}	11^{1}
3. Shipbreaking	—	—	—	3	1	3	7	17	38	131^{1}	31	8	32	32
4. Printing	27^{3}	12	6^{3}	8^{1}	10^{1}	9	12^{1}	11	6^{1}	6^{1}	8	8	10	3
5. Tinning of Metals	3	4	2	2	2	2	1	2	2	3	4	2	3	1^{1}
6. Other contact with molten lead	16	29^{1}	27	7	9^{1}	13^{2}	7^{1}	15	12^{1}	23^{1}	17^{1}	16^{4}	17	9^{1}
7. White Lead	40	18^{1}	17	—	10	17	13^{1}	15^{2}	22	15	12^{1}	8^{1}	12	7^{1}
Red Lead	8	15	13	2	15	11	4	7	15	5^{1}	7	5	9^{1}	2
8. Pottery	26^{4}	23^{7}	15^{7}	11^{1}	21^{8}	25^{13}	35^{11}	42^{17}	44^{11}	47^{18}	47^{5}	41^{14}	14^{6}	23^{10}
9. Vitreous Enamelling	5^{1}	5	1	—	1	2	8	3	5	9	9^{2}	8	12	23
10. Electric Accumulators	64	44^{1}	27^{1}	16	48^{2}	47^{2}	35	32	95^{2}	101	73^{1}	52	58	33^{1}
11. Paints and Colours	12	22	10	3	11	9	13^{1}	14^{1}	11^{1}	15	8	10	6	12^{1}
12. Indiarubber	8	9	8	7	5	7	4^{1}	3	5	3	2	2	2	1
13. Coach Building	39^{5}	33	21^{2}	12^{3}	11^{3}	13	20^{1}	15^{1}	13^{3}	30^{4}	23^{1}	14^{2}	14^{3}	18^{3}
14. Shipbuilding	18^{2}	25^{3}	19	9^{2}	8^{2}	9	4^{1}	12^{1}	8^{1}	8^{1}	13	8	10^{1}	7^{2}
15. Paints used in other Industries	16^{2}	20	20^{1}	15	9^{3}	10^{1}	12	23^{2}	21	24^{2}	14^{1}	16^{3}	7	11
16. Other Industries...	35^{1}	38^{4}	51^{6}	13^{1}	13^{1}	18^{1}	23^{1}	19	13^{2}	22^{2}	29^{1}	11	11^{1}	10
TOTAL	381^{21}	348^{21}	317^{21}	144^{11}	207^{26}	243^{23}	230^{23}	247^{26}	337^{25}	486^{32}	326^{13}	242^{28}	249^{14}	239^{23}
House Painters	108^{29}	52^{15}	43^{13}	25^{13}	37^{16}	46^{21}	42^{15}	40^{12}	53^{17}	75^{9}	88^{9}	90^{18}	98^{21}	87^{20}
House Plumbers	23^{8}	20^{5}	14^{5}	10^{7}	3^{1}	10^{6}	8^{4}	16^{5}	17^{7}	13^{1}	12^{3}	16^{5}	12^{3}	18^{6}

LEAD POISONING*

Year.	Phosphorus Poisoning.	Mercurial Poisoning.	Arsenical Poisoning.	Toxic Jaundice.	Anilin Poisoning.	CS2 Poisoning.	Chronic Benzene Poisoning.
1900	3	9	22^{3}	—	—	—	—
1901	4	18	12^{1}	—	—	—	—
1902	1^{2}	8	5	—	—	—	—
1903	—	8	5	—	—	—	—
1904	1^{1}	3	5	—	—	—	—
1905	3^{1}	8	1	—	—	—	—
1906	—	4	5	—	—	—	—
1907	1^{1}	7	9^{2}	—	—	—	—
1908	1	10	23^{1}	—	—	—	—
1909	3	9	4	—	—	—	—
1910	—	10^{1}	7	—	—	—	—
1911	—	12	10^{1}	—	—	—	—
1912	—	17	5	—	—	—	—
1913	—	14	6	—	—	—	—
1914	—	10	2^{1}	—	—	—	—
1915	3	6	3	—	—	—	—
1916	2	17	—	206^{57}	—	—	—
1917	3	19	30^{5}	190^{44}	—	—	—
1918	3	9	3^{1}	34^{10}	—	—	—
1919	1	7	4	3^{3}	—	—	—
1920	—	5	3	6^{2}	—	—	—
1921	—	—	1	1^{1}	—	—	—
1922	—	6	—	3	—	—	—
1923	—	4	—	7^{2}	—	—	—
1924	—	5	6^{1}	3	—	—	—
1925	—	5	6	2^{1}	31^{1}	3	—
1926	—	4^{1}	5^{3}	2	33^{1}	1	1
1927	—	3^{2}	3^{1}	3	38^{1}	—	—
1928	—	4	2^{1}	6	41	1	—

EPITHELIOMATOUS ULCERATION.

Year.	Pitch.	Tar.	Paraffin.	Oil.	Total.
1920	32	10^{1}	3	—	45^{1}
1921	24^{2}	8	—	—	32^{2}
1922	23^{1}	4^{1}	5^{1}	—	32^{3}
1923	25^{2}	11^{1}	6	16^{1}	58^{4}
1924	23^{1}	8^{4}	2^{1}	90^{1}	123^{24}
1925	35^{4}	28^{5}	4	93^{4}	160^{55}
1926	49	27^{14}	2	109^{8}	187^{49}
1927	34^{1}	24^{8}	6	110^{4}	174^{49}
1928	32	36^{19}	2^{1}	105^{3}	175^{59}

CHROME ULCERATION.

Year.	Bichromate Manfc.	Dyeing & Finishing.	Chrome Tanning.	Other.	Total.
1920	77	43	4	2	126
1921	13	14	2	—	29
1922	10	26	1	5	42
1923	7	35	3	13	58
1924	11	18	6	10	45
1925	5	32	8	9	54
1926	2	33	2	18	55
1927	12	25	7	21	65
1928	3	28	4	35	70

* The raised figures refer to deaths.

ANTHRAX.

Year.	Wool.	Horsehair.	Hides and Skins.	Other Industries.	Total.
1900	10^{2}	12^{3}	9^{1}	6^{1}	37^{7}
1901	8^{5}	9^{1}	20^{5}	3	40^{11}
1902	13^{2}	10^{2}	11^{5}	4	38^{9}
1903	26^{7}	7^{1}	12^{1}	3^{3}	48^{12}
1904	16^{2}	12^{4}	18^{3}	4^{1}	50^{10}
1905	35^{13}	7^{1}	17^{4}	1^{1}	60^{19}
1906	30^{9}	10^{4}	19^{7}	10^{3}	69^{23}
1907	24^{3}	17^{4}	12^{2}	5^{2}	58^{11}
1908	19^{3}	10	13^{1}	5^{3}	47^{7}
1909	29^{3}	8^{2}	18^{6}	1^{1}	56^{12}
1910	28^{3}	6^{1}	14^{3}	3^{2}	51^{9}
1911	35^{10}	8^{1}	20	1	64^{11}
1912	31^{6}	7	8	1	47^{6}
1913	43^{5}	5^{1}	19^{2}	3	70^{8}
1914	29^{5}	5	15^{1}	6^{1}	55^{7}
1915	26^{2}	2	18^{3}	3^{1}	49^{6}
1916	80^{12}	6^{3}	18^{3}	2	106^{18}
1917	65^{11}	1	29^{2}	4^{1}	99^{14}
1918	49^{4}	4^{2}	14^{1}	1	68^{7}
1919	34^{5}	3^{1}	16^{1}	4^{2}	57^{9}
1920	25^{7}	5^{1}	17^{3}	1	48^{11}
1921	11^{3}	4^{1}	8^{1}	2^{1}	25^{6}
1922	19^{3}	9^{1}	16^{1}	1	45^{5}
1923	14^{1}	9^{2}	22^{1}	1^{1}	46^{5}
1924	19^{1}	4^{1}	16^{2}	4	43^{4}
1925	25^{4}	3^{2}	16^{3}	1	45^{9}
1926	15^{2}	8^{1}	12	3	38^{3}
1927	18^{1}	3^{1}	9	1	31^{2}
1928	14^{2}	4^{1}	24^{3}	3^{2}	45^{8}

APPENDIX II.

ANALYSIS OF REPORTS ON 10,923 CASES OF LEAD POISONING.

I analysed 10,923 cases of lead poisoning notified and reported under section 73 of the Factory and Workshop Act, 1901, according to: (1) the severity of the attack; (2) the number of the attacks; and (3) the main symptoms in four quinquennial periods as set out below. The reports were those made by Certifying Factory Surgeons.

In general, "Severe" includes: (*a*) Paralysis; (*b*) encephalopathic conditions—convulsions and mental affections; and (*c*) grave undermining of the constitution associated with Bright's disease and arterio-sclerosis. "Moderate" includes: (*a*) a combination of colic with anæmia; (*b*) profound anæmia; (*c*) partial paralysis; and (*d*) cases in which there is constitutional debility. "Slight" includes: (*a*) colic, constipation and rheumatic pains; (*b*) anæmia; and (*c*) either of the above with muscular weakness.

Number of attacks has reference to definite occurrence of disability. Cases appearing under 3rd or chronic would generally have appeared also under "Severe" attacks.

The total number of symptoms greatly exceeds the number of cases, but this does not affect the correctness of the estimate of each one as a proportion

on the total number reported. Nearly always a combination of symptoms —colic, anæmia, headache, etc.—is described as present.

The Tables show a noticeable decline in the severity of the cases in the last quinquennial period as compared with the first two.

Cases showing encephalopathic symptoms are very distinctly fewer, and cases of paralysis fewer than they used to be, although it should be remembered that the separation of " weakness of the arms " as an entry was included under " paralysis " until 1909 and therefore swells the figures under that heading.

Paralysis appears to be commoner in men than in women ; headache and encephalopathy, on the other hand, commoner in women than in men.

NUMBER OF ATTACKS.

		1st.		2nd.		3rd or chronic.		Not stated		Total.	
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900-04	Cases ..	2,019	419	462	87	460	26	131	32	3,072	564
	Per cent...	65.7	74.3	15.0	15.4	15.0	4.6	4.3	5.7	100	100
1905–09	Cases ..	1,781	380	409	32	298	20	77	5	2,565	437
	Per cent...	69.4	86.9	15.9	7.3	11.6	4.6	3.0	1.1	100	100
1910–14	Cases ..	1,863	260	305	17	251	8	32	6	2,451	291
	Per cent...	76.0	89.4	12.5	5.8	10.2	2.7	1.3	2.1	100	100
1920–24	Cases ..	1,117	114	98	5	181	22	5	1	1,401	142
	Per cent...	79.7	80.3	7.0	3.5	12.9	15.5	0.4	0.7	100	100

SEVERITY OF ATTACK.

Year.		Severe.		Moderate.		Slight.		Not stated.		Total.	
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900–04	Cases ...	1,020	137	640	128	1,324	273	88	26	3,072	564
	Per cent...	33.2	24.3	20.8	22.7	43.1	48.4	2.8	4.6	100	100
1905–09	Cases ...	568	67	749	141	1,198	223	50	6	2,565	437
	Per cent...	22.1	15.3	29.2	32.3	46.7	51.0	1.9	1.4	100	100
1910–14	Cases ...	450	27	790	117	1,184	141	27	6	2,451	291
	Per cent...	18.4	9.3	32.2	40.2	48.2	48.5	1.1	2.1	100	100
1920–24	Cases ...	201	14	460	55	736	72	4	1	1,401	142
	Per cent...	14.3	9.9	32.8	38.7	52.5	50.7	0.3	0.7	100	100

MAIN SYMPTOMS.

Year.		Gastric.		Anæmia.		Head-ache.		Paretic.		Encephalopathy.		Rheumatic.		Other.	
		M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
1900-04	Cases ..	2,521	431	619	132	278	120	577	68	113	45	289	64	47	5
	Per cent.	82.1	76.4	20.2	23.4	9.0	21.3	18.8	12.0	3.7	8.0	9.4	11.3	1.5	0.9
1905-09	Cases ..	1,991	348	854	193	261	135	613	85	87	17	279	43	129	11
	Per cent.	77.6	79.6	33.3	44.2	10.2	30.9	23.9	19.5	3.4	3.9	10.9	9.8	5.0	2.5
1910-14	Cases ..	1,853	225	825	112	303	81	333	15	53	10	293	28	186	12
	Per cent.	75.7	77.3	33.7	30.5	12.4	27.0	13.6	5.2	2.6	3.4	12.0	9.6	7.6	4.1
1920-24	Cases ..	1,133	102	519	69	130	33	99	7	15	3	97	15	146	22
	Per cent.	80.9	71.8	37.0	48.6	9.3	23.2	7.1	5.0	1.1	2.1	6.9	10.6	10.4	15.5

THE GARDEN TULIP.*

By SIR DANIEL HALL, K.C.B., D.Sc., LL.D., F.R.S., M.R.I.

The tulip is not an English or even a European flower. In Europe there is possibly one wild species, *T. australis*, the nodding headed yellow "tulip of Bologna" of the early herbalists, which is possibly wild in the Apennines, in Sicily, in the Cevennes and some localities in Spain and Portugal. But the species which is sometimes credited with being wild in England, *T. silvestris*, is undoubtedly a garden stray, which both here and on the Continent is only found on land that has at some time been cultivated. The garden tulip first became known to Western Europe through Busbequius, an ambassador of the Emperor to the Sultan, who met with them on his way to Constantinople in 1554. Busbequius sent home bulbs and seeds; there were other sources of importation, and the first record we have is that Gesner saw one blooming in 1559 in the garden of Councillor Herwart in Augsburg. As a flower it leapt into instant fame, and as it was a time of great activity in gardening, by the close of the century, the tulip was widely distributed in Vienna and Germany, in Holland and Flanders, in England, France and Northern Italy.

But the tulip when it arrived from the East was already a made flower—that is, it possessed a number of varieties which, however, in the general run of their characteristics do not differ at all from those we grow to-day. The original tulip had narrow petals which came to a point—many of the existing garden tulips still have that character—but the Western gardeners have selected by preference tulips with short rounded broad petals forming a cup. It is still unknown how this Eastern garden tulip arose. None of the species that have since been discovered in Western or Central Asia, the real home of the genus, can be appealed to with confidence as the source of the garden tulip. Nearly all the varieties of the garden tulip are fertile with one another, which is some argument against a hybrid origin. Again, among the garden tulips are both white and yellow grounds, yet no species akin to the

*Abstract of a paper read before the Royal Institution of Great Britain on May 3rd, 1929.

garden tulip possesses a white ground. One might still suppose that the white ground had arisen in cultivation as a "mutation," were it not for the fact that the white ground behaves as a simple " dominant " to the " recessive " yellow ground, and dominant mutations are very rare. For the present we can do little more than speculate about the origin of the garden tulip ; we shall probably get some light from breeding experiments with tulip species, but these are slow, because it takes six years before a tulip-seed reaches the flowering stage. The origin is certainly remote in time ; the locality, probably Persia. All the Eastern peoples call the tulip by its Persian name, lalé. Our name tulip is equivalent to turban, and is due to a misapprehension on the part of Busbequius, who probably thought his interpreter was giving him the name of the flower when he was really comparing it to a fez. From its earliest arrival in Europe the garden tulip showed one peculiarity exhibited by no other flower. The seedlings are self-coloured when they first bloom, pink, crimson, or purple, or brown, orange or scarlet. Suddenly, in any year, some of them may become variegated, and show crimson or purple streaks upon a white ground, or brown streaks upon a yellow ground. This change is called " breaking," and is permanent in the sense that the offsets from the bulb that broke are also broken. Yet it is not reproduced in the seed from the broken bulbs, and is, therefore, not a case of " sporting " in the usual horticultural sense of the word. The broken tulips are always a little smaller and the plants less vigorous and less productive than the breeders from which they originate. The variegation is to be seen in the leaves as well as in the flower. The broken flowers have always been most prized by the fanciers ; formerly the early unvariegated forms were only kept as stepping-stones to the broken varieties, and were known as " breeders." Nowadays it is the breeders that are chiefly grown for decorative purposes.

Breaking remained unexplained until recently, when certain analogies led to the suggestion that it might be due to a " virus," one of the ultra-microscopic filter-passing agents such as cause mosaics and variegation in Abutilon, Potato, and Tomato. Last year Miss D. M. Cayley at the John Innes Horticultural Institution succeeded in grafting unbroken tulips on broken ones, whereby they were induced to break to the extent of over thirty per cent. in the first season. Similarly introducing plugs of broken tissue into unbroken bulbs induced breaking, so that the evidence is strongly in favour of breaking being induced by the transmission of a virus. The question is then of the agent effecting the transmission in nature. With many plants some species of aphis carries the virus, and at least four species of aphis are found on the tulip at some stage or other. A year or two back Dr. E. J. Collins, of the John Innes Institution, got evidence in favour of transmission by aphis, but not conclusive, because the controls were not free from infection. More extensive trials are being conducted by Mr. McKenny Hughes with each of the four species of aphis, in one case with a positive result as far as one season's test can be trusted. It is, perhaps, significant that the aphis inculpated, *Myzus persicæ*, is the chief transmitter of potato mosaic. While the story is still incomplete, the hypothesis that breaking is due to a transmissible virus is at least reasonably probable. The old florists were always looking for methods that would make tulips break, and now we should be able to do it with some certainty. But the modern commercial tulip-grower is anxious to keep his tulips from breaking, because there is little or no demand for the breaks that come from the favourite market and decorative varieties. If we can fix the transmission of the virus upon a particular aphis it will be easy to find a method of keeping the tulip-beds free of that carrier.

There are several other strange " sports " among tulips. For example " parrot tulips," with the petals cut and laciniated, and splashed with body-colour and even

with green, have been known since 1665. Most of the parrot tulips are yellow-ground varieties of unknown origin, but of recent years one or two with white grounds have arisen among known varieties as "sports." Whether they breed as such has never been ascertained. It seems a good working hypothesis to suppose that "parroting" is also due to a virus or a combination of viruses, and Miss Cayley has started up experiments to test this idea. Sports of a normal type are not unknown among tulips, generally a colour-change, as, for example, to a deeper shade of pink. Sometimes the ground-colour changes, and a tulip that is flushed with pink on a white ground throws a sport flushed with orange on a yellow ground. It is noteworthy that the only changes of this kind recorded are from the white to a yellow ground, from the dominant to the recessive, as though the change came about by loss.

One kind of sport, however, remains inexplicable the occurence of "thieves." A thief is a sport which has been known to occur in many varied stocks of tulips, and the odd thing is that the thief is much the same sort of tulip, whatever the variety from which it has been originated. It is a narrow-petalled, weak-looking flower, flushed with pink on a ground often tinged with yellow, so characteristic that in the past it was even endowed with specific rank as *T. platystigma*. Though thieves have been known for a long time, it has only recently been made certain that they represent definite changes in a variety, and are not rogues due to accidental mixture of another stock. Till they have been investigated by breeding experiments it is almost useless to speculate on their nature.

Last autumn various tulip bulbs just starting into activity were exposed to X-rays (90,000 volts) for half-an-hour. They are now flowering, and in all cases the flowers have narrow pointed petals, the foliage is also drawn up and pointed. The anthers and pollen appear unchanged, the ovaries have been destroyed. Whether this curious change is permanent, and what other changes in the plant accompany it, has yet to be ascertained. It will be evident that much research is called for, and will inevitably be a lengthy affair, since each generation will require at least six years to reach the flowering stage.

TRADE IN THE HWAI RIVER BASIN (CHINA).

The Hwai River is one of the many little-known rivers of China of much importance in the distribution of trade, writes, the United States Consul at Nanking. It rises in the south-eastern corner of Honan Province and flows eastward through the Province of Anhwei into Hungtze Lake, whence its waters find egress through the Grand Canal to the mighty Yangtze. The Hwai and its tributaries, in conjunction with the Tientsin-Pukow Railway and the Grand Canal, form a natural system for the assembly and distribution of merchandise throughout all north central Anhwie, serving with remarkable facility and completeness the traffic needs of one of the most thickly populated regions of China.

Many centuries ago the Hwai discharged its waters into the Yellow Sea near Haichow, in Kiangsu Province, while the Yellow River, "the scourge of China," discharged into the sea near Tientsin; but about the thirteenth century calamitous floods broke into the dykes of the Yellow River and pushed its entire volume across country and into the channel of the Hwai. After their union the greater river forced the lesser from its bed and the waters of the latter sought a new outlet across the low-lying lands west of the Grand Canal to the River Yangtze.

For the past three-quarters of a century the constant menace to the entire Hwai River Basin from frequently recurring floods has occasioned many plans

for dyking and drainage of the river and for the maintenance and improvement of the Grand Canal. In 1914 engineers who were sent out by the American Red Cross made a thorough investigation of flood-prevention possibilities, and six years later a distinguished American engineer presented to the Chinese Government an exhaustive plan for draining the Hwai River Basin into the sea at a cost of less than $6,000,000 in gold, as compared with previous plans for an estimated cost of $90,000,000.

The Hwai Basin embraces approximately 21,600 square miles of an exceedingly fertile and productive country. Over 90 per cent. of the population is made up of farmers, and the principal crops grown are wheat, soy beans, sesamum, kafir corn, maize, China jute, tea, and rice, and approximately 60 per cent. of the farms are double-cropped. Of those crops which furnish an exportable surplus and whose yields serve as indexes of the purchasing potentialities of the people, wheat constitutes, roughly, 50 per cent. and soy beans 30 per cent.

Pengpu, the most important trade centre of the region, is situated at the intersection of the Tientsin-Pukow Railway and the Hwai River, 100 miles by rail from Pukow. All the produce of the region is gathered here and carried by rail to Shanghai, while imported goods come up from the coast ports by rail to Pengpu and are thence distributed by junk service on the Hwai or its tributaries throughout the interior.

The greater part of the trade of the Hwai River district is in the form of indirect barter, mainly owing to the absence of modern banks in nearly all the interior cities and towns, and because most of the Chinese firms bringing foreign goods into the Hwai River Valley pay for them by sending out local agricultural produce. When imported goods are sent up country, the consignee is debited with the amount of their cost, and when beans, wheat, hemp, or other products of the interior are sent down, the amounts realised from them are placed to his credit. Where currency is used, the general media of exchange are the Chinese silver dollar and the fractional silver 25 cent and copper 1 cent pieces, whose exchange rates are subjected to constant and wide fluctuations. In the district served by the Pi River, a tributary of the Hwai, there are practically no Chinese silver dollars, their place being taken by Spanish dollars, whose mint dates vary from 1773 to 1810. It is one of the curiosities of trade that these old Spanish dollars circulate at a premium.

A considerable variety of foreign manufactures is now sold in the Hwai River Valley. The more important lines are cigarettes, kerosene oil, sugar, indigo, cotton goods, soda, paper and matches, but less important commodities which also find a good sale are wire, nails, galvanized-iron sheets, lamps and lanterns. Imports emanating from the United Kingdom are soda, sugar, cigarettes, cotton goods, and kerosene oil. Germany has a share in the indigo market and in various lines of cheap hardware, while Japan supplies cheap hardware, enamel and aluminium ware, cotton goods and sugar.

Every district of China has evolved a special type of watercraft to meet the requirements of its streams, and along the Hwai and its tributaries are found junks and sampans of a surprising diversity of construction, each devised for some special purpose. In the smaller streams, such as the Pi, during the dry seasons the water is so low and rapids so frequent that even junks of the shallowest draft cannot operate. Here the ingenious Chinese boatman has evolved a unique type of raft-boat, made by fastening bamboos together so as to form a platform capable of supporting no small amount of cargo, but which will float in no more than a few inches of water. The forward ends of the bamboos are bent upward, to prevent the rafts catching on rocks or other obstacles as they glide over the shallow waters.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

CHANGE OF TELEPHONE NUMBERS.

The Society's Telephone Numbers have been changed and are now :—
General Number, Temple Bar 5610.
Examinations Number, Temple Bar 2785.

PROCEEDINGS OF THE SOCIETY

SHAW LECTURE.

THIRTY YEARS' EXPERIENCE OF INDUSTRIAL MALADIES.

By Sir Thomas Morison Legge, C.B.E., M.D.,
late H.M. Senior Medical Inspector of Factories.

III

Compensation for Industrial Diseases.

(Delivered March 4th, 1929.)

In the last course of Shaw lectures given here in 1907 Sir Herbert Samuel, as Chairman, made some remarks which might fittingly introduce my lecture to-night on "Twenty Years of Compensation for Industrial Diseases." He came fresh from having steered successfully through Parliament the "Workmen's Compensation Act, 1906", which, for the first time, brought industrial diseases under the Act for purposes of compensation on the same lines as accidents. "One might look forward," he said, "to the time when the principle would become recognised that there should be no such thing as industrial disease possible. They might be far away from that day, but he thought

that was the goal. . . . It was the duty of scientists to discover the remedies for preventing industrial diseases, and he held it was one of the prime duties of the State as soon as the remedy was found to require that it should be adopted."

In the controversies which have centred round the modern factory system the student can readily distinguish three periods in which a fresh distinct appeal was made to the mind of the thinking public on the score of health. The first period was much the longest, extending over about half a century, from before 1800 to 1850, and the controversies waged during it were excited by concern at the excessively long hours worked by children and the extreme instances of fatigue among them Inquiry into these long hours disclosed well nigh unbelievable facts which are to be read in the evidence taken before the Royal Commission appointed in 1833.

In the controversies over this period the names of Dr. Thomas Perceval, of Manchester, Owen, Oastler, Sadler, Shaftesbury and Thackrah, are household words. As a result of outside pressure from men such as these, before 1850 the hours were limited to ten a day, and of children under 11 to the same hours on alternate days, or half time, with compulsory school attendance.

The second period extended from 1850 to about 1890 and was mainly taken up with concern over the toll taken in life, and danger to limb from accidents from machinery, and with legislation for preventing them by guarding. From about 1870 onwards, industrial diseases became more and more prominent. Notable features of the factory legislation between 1878 and 1895 were the provisions made to control dangerous trades by means of special rules and to obtain early knowledge of certain occupational diseases by placing the obligation to notify them on the medical practitioner and the occupier. Finally, under the Workmen's Compensation Act, 1906, twenty-five occupational diseases were scheduled to which the Act, with differences depending on the essential distinction between accident and disease, applies and to this list others have been added from time to time since, and to-night I deal with a few of them.

In the last two lectures I laid stress on the fact that samples of the eleven notifiable diseases which medical practitioners are called upon to report suffice, the object being to afford a clue to the factory inspector of conditions over which he can exercise control.

The objects of the Workmen's Compensation Act and of the Factory Act are not the same. The Compensation Act is wider, as it is intended to cover *all* cases of sickness of strictly occupational origin. The individual is here concerned, and not merely the conditions under which he works. Any description of disease, therefore, for which compensation can be claimed must be worded very widely, so as to sweep into the net all cases and not merely those with marked symptoms. Hence it is that in the description (and a very essential part the description plays) of the diseases scheduled for compensation the broadest possible designation is given, including the sequelæ, and a wide

description also is given of the process or processes in which it is presumed that the worker was engaged when he contracted the malady.

There are now some thirty-three diseases to which the consolidated Act of 1925 applies. A glance at the list reveals the absence of certain forms of poisoning and well-recognised trade diseases which might have been expected to find a place.

TESTS APPLIED TO EACH DISEASE.

For the reasons which dictated the omission of certain diseases we must look to the tests applied to each disease by the Committee on Compensation for Industrial Diseases before the disease in question was held to come within the scope of the provisions and intentions of the Act. They were:

1. Is it outside the category of accident and diseases already covered by the Act?

2. Does it incapacitate for more than a week?

3. Is it so specific to the employment that causation by the employment can be established in individual cases?

You do not find poisoning by sulphuretted hydrogen gas in the list because it was thought then to be invariably sudden and, therefore, in the nature of an accident, so that after-effects can be referred back to the definite time when inhalation occurred. But such acute poisoning is already covered by the Act, and only poisoning which is slow and insidious in onset and which might not easily be referred back is not covered. Poisoning of this slow type may result from nitrous fumes, carbon bisulphide, or from chronic benzol poisoning, and they are all included. In my first lecture I explained why now I think the same view should be taken of the chronic effects of sulphuretted hydrogen gas which are found in the artificial silk industry by the viscose process. Poisoning by carbonic oxide does not find a place because no convincing evidence was presented to the Committee that it should be treated otherwise than as an accident. There would have been danger in scheduling the sequelæ of carbonic oxide poisoning, such as loss of memory and dementia, seeing how widespread is the use of gas in industry, and how easily subjective symptoms from it might be alleged with a view to putting up claims for compensation.

In the very rare instances in which hernia can be ascribed to a sudden strain, it would come within the definition of an accident. The Committee of which I was a member on the evidence heard, could not regard hernia as an industrial disease, nor as an injury, not being an accident due to employment.

The second test excludes a malady like brass-founders' ague, as the attack is transitory and does not last a week nor the three days to which the waiting time for the award of compensation has been reduced. Similarly, boiler-makers' deafness, very, very trying condition as it is, causes no absence from work.

The third test probably excludes the largest number of industrial maladies, namely, those such as bronchitis due to the inhalation of dust because the

symptoms are not sufficiently distinctive to enable one to say whether dust or chill was the cause. The one disease which the Committee considered to be a sufficiently distinguishable trade disease, but nevertheless decided, at any rate for the time being, not to recommend its inclusion, was silicosis. They felt this course was best in the interests of the workmen themselves, because in no other of the diseases considered was there so long a preliminary period during which there are equivocal symptoms—cough and the like—which may or may not become graver and ultimately declare themselves as the disease for which compensation is payable. Every case of cough in a stone-mason, for example, might arouse suspicion that it was a symptom of the incurable disease, involving payment of a large sum in compensation, and unemployment among persons so suffering would, it was feared, inevitably result, because employers might dismiss them before incapacity had arrived. It is not loss of employment but incapacity which entitles to compensation. How this difficulty has been overcome I shall describe later.

With the exception, therefore, of fibroid phthisis (silicosis) the intention of the government was to schedule every strictly industrial disease which complied with the principles of selection. This explains inclusion of some extremely rare diseases, such as nickel carbonyl poisoning, poisoning from African boxwood, manganese poisoning, and exclusion of the group of ordinary infectious illnesses—measles, scarlet fever, etc.—when contracted by a laundry worker, for example, through chance exposure to infection.

At the outset I want to say how much help the Committee received from Trade Union Secretaries. At least three of the diseases were scheduled largely as the result of evidence heard from them—glassworkers' cataract, epitheliomatous ulceration, and poisoning from African boxwood.

I have shown in Charts VIII, IX and X some of the principal maladies over the years for which compensation figures are available—1908-1914 and 1919-1926—bringing out thereby their tendency to rise. And here again I would say the charts are drawn to show the peaks and the contrasts. The actual figures for each year for (1) new cases in the year which are shown black; and (2) cases carried on from previous years (shown grey) are given in appendix 3. The number of cases to the square and the scale generally of charts VIII and IX is the same as in No. I. Of the eleven notifiable diseases, therefore, comparison can be made of the number that received compensation and the number that were notified. According to the published statistics of compensation the number obtaining compensation is always less than the number notified. This must mean either that several are settled without formality, or that the workman does not trouble to make a claim perhaps for fear of losing his job. For this Act is the Cinderella among Acts of Parliament, as it is no person's duty to see that its requirements are fulfilled. Even the person most qualified to do so, the factory inspector, is enjoined not to touch it.

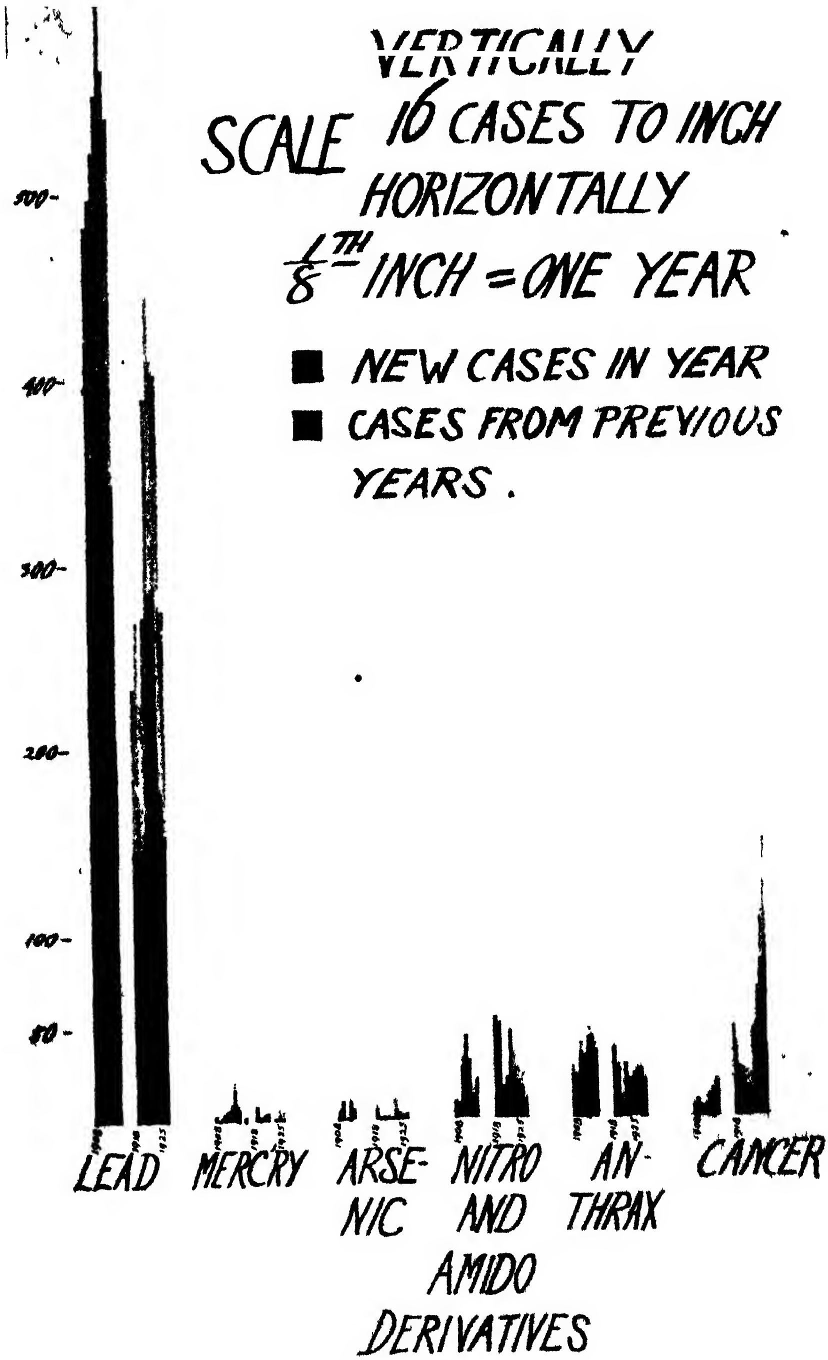
VERTICALLY
SCALE 16 CASES TO INCH
HORIZONTALLY
1/8TH INCH = ONE YEAR
NEW CASES IN YEAR
CASES FROM PREVIOUS YEARS.
500
400
300
200
100
50
LEAD
MERCRY
ARSE-NIC
NITRO AND AMIDO DERIVATIVES
AN-THRAX
CANCER

CHART VIII.

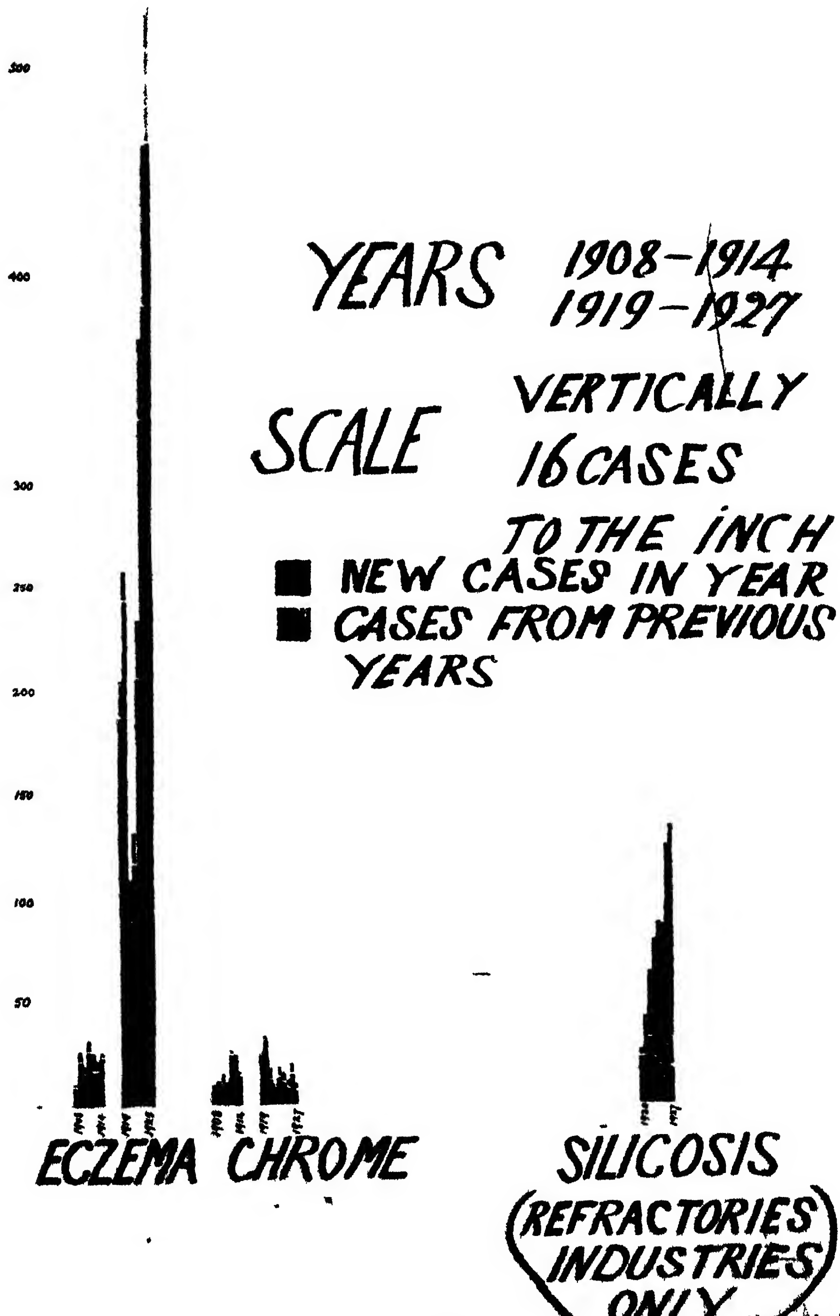
500
400
300
250
200
150
100
50
YEARS 1908–1914
1919–1927
SCALE VERTICALLY
16 CASES
TO THE INCH
NEW CASES IN YEAR
CASES FROM PREVIOUS YEARS
ECZEMA
CHROME
SILICOSIS
(REFRACTORIES INDUSTRIES ONLY)

CHART IX

When we come to deal with miners' maladies, so many are they that the scale of Chart X for them has been reduced eight times as compared with the factory cases

One interesting thing brought out is how the figures show at a glance which are the chronic maladies, like lead posioning and miners' nystagmus, and which the acute, like all the others nearly, the light grey representing cases carried over from previous years and not deaths as in charts I, II and III. Thus the remarkable contrasts between some, like skin cancer and miners' nystagmus, and others like beat hand The cases (both new and old) of cases of compensation for skin cancer have risen from 7 in 1908 to 74 in 1927, the last year for which statistics are published, those from dermatitis and eczema from 270 in 1919 to 1047 in 1927, and from silicosis (for the refractory industries alone) from 51 in 1919 to 269 in 1927. Miners' maladies constitute over 90 per cent. of the total cases due to occupational diseases scheduled under the Act.

Consider for a moment the amount of invalidity represented by the figures for lead poisoning alone. Plumbism is a chronic malady involving disability in the acute cases for four weeks seldom less--and in the severe chronic cases for months Taking an average absence from work of two months per case, the figures for 1914 alone represent ninety years of lost time, to say nothing of the disorganiastion of home life brought about by the illness.

From time to time as experience and outside pressure has shown to be desirable, the description of the scheduled diseases has been altered. This has always been in the direction of widening the scope so as to enable the workman to obtain compensation more easily. The first Committee which drew up the list was inclined, not wishing to take a leap in the dark, to make the right to claim compensation not too easy. Thus " eczematous ulceration " was scheduled, intending thus to indicate that dermatitis was not quite the same thing. Later experience showed that dermatitis was really in distinguishable from eczematous ulceration or, at any rate, that those suffering from it were as much deserving of compensation as for the graver condition, and now the description of the disease has been altered to" (*a*) dermatitis and (*b*) ulceration of the skin produced by dust and liquids." Similarly, poisoning by " nitro and amido derivatives of benzene " was not wide enough to include T.N.T., and it was necessary to alter the schedule to read " nitro and amido derivatives of benzene *and its homologues.*"

Are any other maladies ripe for scheduling? I think there are two — (1) chronic poisoning by sulphuretted hydrogen gas, which sets up tiresome irritation of the eye and the symptoms of " sick headache " among those exposed to traces of it in the air of chemical and artificial silk works; and (2) asbestosis which will have to be dealt with on precisely the same lines as silicosis with which in its symptoms and terminal phase of tuberculosis it somewhat resembles.

Much romance attaches to the manner in which some of these maladies finally, in spite of much contradictory evidence, came to be scheduled. Mr. Alfred Greenwood, the partially blind Secretary of the Glass Bottle Makers of Yorkshire United Trade Protection Society, had noticed, his inquiries starting in 1891, how frequently cataract was signalised as the cause of incapacity which brought members on the superannuation funds of the society—a notable instance of the value of the material in such Society records, if only they are properly used. Later a new Eye Hospital was opened at Sunderland, and Dr. W. Robinson[1] described in 1903 how the cases of cataract which came before him among glass bottle finishers (who spent their time exposed to the glare from the glory hole of the glass furnace at a temperature of about 1,500° C.) were all of a particular type—a posterior cortical cataract commencing right in the optical centre of the eye. These facts and other statements which conflicted with them, were given in evidence before the Committee and made it difficult—nay, impossible—to schedule the condition with the others at the time of reporting.

I was deputed to try and settle the question of whether the malady should be scheduled or not. For that purpose I examined the crystalline lenses of 513 glass workers exposed to the glare and heat and, as a control, of 278 as I thought, not so exposed. The difference in the character of the changes observed was very striking and of unmistakable significance. Thus of the control persons none had sought treatment for cataract and in not more than three were the opacities such as to impair sight. Among the glass workers, in addition to six in whom a single extraction for cataract had been performed, and in one, a double extraction, there were at least 25 others in whom the sight of one or other of the eyes was seriously impaired. Typical central posterior cortical change of varying degree was noted in 56 lenses of the 513 glassworkers and in two of the 278 control persons examined.

The only one with clearly developed posterior cortical cataract among the controls was a worker at Woolwich Arsenal who turned out to have been engaged for years in looking after an annealing furnace—on work similar to that of the glass finisher. He was, therefore, the exception which proved the rule.

Approaching the problem from another side—that of superannuation from disablement by cataract—I found that useful comparison could be made between the reported incidence of the malady on 10,549 members of the Hearts of Oak Benefit Society in receipt of reduced sick allowance and that on 186 superannuated members of glass-bottle societies. The percentage of cataract in the former was only 0.78, and in the latter 22.6, although the average age in both was about the same—56 years.

[1] His paper, together with other literature on Glassworkers' Cataract, is printed in full in the Second Report of the Committee on Compensation for Industrial Diseases (Cd 4387), 1908.

There could be no hesitation now in scheduling the disease unless it should prove to be against the interests of the workers themselves on account of the probable effect of such a course upon the prospects of employment of the men affected. The disease is one of very slow growth. For many years the efficiency of the workman at his trade is little, if at all, affected. During that period it would be impossible for him to claim that the disease had incapacitated him and that he ought to be compensated. But at any time an opthalmoscopic examination of the eyes would clearly reveal the disease in an incipient stage, forecasting the possible ultimate incapacity of the workman. If the law required that half-wages should be paid during the rest of the life of an artizan who had lost his technical skill through cataract, it would not be unnatural to expect that employers would insist that their men should submit to an examination of the eyes; that no employer would engage a workman, seeking employment, who showed traces of the malady; and that some employers would even dismiss workmen so affected before the time arrived when a claim for compensation could be established.

The Committee came to the conclusion that if the disease were scheduled in the same manner as other industrial diseases, the work people would lose more than they would gain, as the employers might require them to undergo an opthalmological examination, and the presence of the black dot in the centre of the pupil would be an indication for dismissal long before the disease was incapacitating. The surgical operation of removal of the cataract would come to the rescue primarily of the sufferer, but secondarily of the Committee in helping to a decision of how the malady should be dealt with for purposes of compensation. The operation for the removal of cataract is attended by practically no danger, and among glassworkers usually enables them to obtain employment again, sometimes even at the highly-skilled work on which they had been formerly engaged. If the period in respect of which compensation were made payable were limited to the time necessary to cover the period of incapacity immediately preceding and succeeding the operation, a just relief would be given to the workmen, while the burden on the trade would be reduced to such very small proportions that no employers would incur the expense of arranging for periodical medical examinations or be guilty of the harshness of dismissing men whom they knew to be suffering from a slowly-ripening cataract. The Workmen's Compensation Act enables such a limitation to be effected without further legislation, so the disease was scheduled for a period not exceeding six months, and for not more than four months unless an operation for removal was undergone. [a]

[a] The conditions under which cataract is now scheduled under the Workmen's Compensation (Industrial Diseases) Consolidation Order, 1929, is as follows:—

A person suffering from cataract shall not be entitled to compensation under the provisions of the said section on account of that disease for more than six months in all, or for more than four months unless he has undergone an operation for cataract.

Provided that where the judge, committee or arbitrator is satisfied on the advice of the medical referee that an operation could not for medical reasons be performed within four months from the date of disablement, or that having undergone an operation, the worker is still disabled by the cataract after the expiration of six months from such date, compensation may be continued for such further period and subject to such conditions as the judge, committee or arbitrator may direct, without prejudice, however, to the right of review conferred by section 11 of the Act.

But that is by no means the end of the romance. I had to admit after my inquiry that I could not say whether the changes in the lens were caused by the light or the heat rays. That was a problem to be solved by a physicist and not by a medical man. Fortunately the great physicist Sir William Crookes, then in his 77th year, became interested in this aspect. He visited glassworks, finding the heat rays in the radiation from molten glass in far greater abundance than the ultra violet, and from this he inferred that it is to the heat rays rather than the ultra-violet that glass workers' cataract must be ascribed. He set himself the task of adding various metallic oxides to the constituents of glass in order to cut off the invisible rays at the ultra-violet and the infra-red ends of the spectrum, i.e., to cut off those rays which are believed to damage the eyes without, at the same time, obscuring too much light. Finally, he was able to prepare glasses cutting off 90 per cent. of heat radiation, opaque to the invisible ultra-violet rays, and sufficiently free from colour to be scarcely noticeable when used as spectacles. The glasses he describes " include specimens suitable for spectacles adapted to all requirements— from eyes of youth to eyes of age."

Here was the remedy, you will say. Yes—but unfortunately the wearing of goggles is not a means external to the workman over which he can exercise no control. A very careful man might wear them—one, too, who had had the misfortune to lose one eye and wanted to do everything to save the sight of the other—but, generally speaking, with a disease so gradual in its onset and with a remedy having the disadvantage of allowing the sweat to condense on them—glass-finishing is unbelievably hot work—the remedy failed of its intention. Welcome, therefore, to that wonderful machine, the product of American inventiveness, and a means wholly external to the workman, which sucks up automatically the molten metal, automatically carries it to a mould where automatically the bottle is blown and delivered at the rate of forty a minute at a cost in labour about one-ninth that paid for the same number of bottles manufactured by forty men and four boys in the old way. This is the right way of tackling an intractable industrial malady, because, really, no man ought ever to have been asked to carry on glass-bottle making in the way it had to be carried on under a competitive system. Only one thing the machine could not do, and that was to put the glass marble inside the neck of the ginger-beer bottle. That had still to be done by sleight of human hand. Every incandescent electric light bulb is to-day blown by machinery.

What I have described is only a part of the story, as other scientific research work has been carried out under a Committee of the Royal Society.

My inquiry was limited to the work of glass-blowing, but I always felt that if only one had time to follow the same line of inquiry up in other industries, such as iron and steel manufacture, where there is similar exposure to glare from hot furnaces, the same result would be found. This was reserved for Dr. Healy, of Llanelly, to do. He went there, after having held the position

of house surgeon to Dr. W. Robinson in the Sunderland Eye Hospital, and, sure enough, he found what he looked for in the iron and steel rollermen. Now cataract caused by "exposure to rays from molten or red-hot metal" has also been scheduled.

Another Trade Union secretary hurled, metaphorically speaking, a chunk of South African boxwood at the head of the Professor of Botany in Liverpool University, and asked him what it contained to cause the men to feel mazy and dopy, so that they nearly fell off their bench. One indeed said that "he could sleep on a clothes' line." The late Professor Harvey Gibson, with the help of Professor Sherrington (now Sir Charles Sherrington, O.M.), put their heads together and discovered an alkaloid in the wood which was a cardiac poison, inducing a gradual slowing of the heart-beat, that accounted for the symptoms complained of. Now other wood has been largely substituted, because, at the speed which modern machinery works in the making of shuttles—that being the use to which the wood was put—even with the best system of locally-applied exhaust ventilation, some dust must needs be inhaled.

The late Mr. Wignall, M.P. for the Forest of Dean, then Organising Secretary of the Dockers' Union in South Wales, first brought to the notice of the Committee on Compensation for Industrial Diseases the distressing symptoms due to the irritant action of pitch dust on the patent fuel workers in Swansea and Cardiff. It was brought poignantly before them by seeing an Alderman of the City of Swansea, himself a pitch-worker and himself the victim of skin cancer, from which soon afterwards he died. I was also deputed to investigate this condition, and found a true bill, not only in the case of the briquette workers, but also in the case of those using "coal oil" in the manufacture of grease. This also is a very slow-growing condition, in which, once the seeds are sown, even giving up the work will not stay its development. It is really a centuries-old malady, but was thought to be confined to chimney-sweeps. Regularly the Registrar General's Decennial Supplement on Occupational Mortality brought out the high mortality from cancer of the scrotum among chimney-sweeps, but his classification of occupations failed to bring out, as it has enabled him to do in his last Supplement, that other occupations using "tar, pitch, mineral oil or paraffin, or any compound, product or residue of any of these substances," also suffered in the same way as I have already sufficiently described.

These are but examples of the romance underlying the scheduling of a disease under the Workmen's Compensation Act. I can only deal briefly with one more, and that one, perhaps, the most difficult of all, namely, silicosis. The flint knappers in the palæolithic and neolithic epochs must have been the first sufferers. The grinders of armour and of implements of war and the pottery makers in the middle ages yielded, as Ramazzini tells us, their quota. And in the building of cities like Edinburgh and the Yorkshire cities of freestone and sandstone thousands of masons' lives must have been sacrificed. Only

recently, following on the success with which its devastating effects had been combated in the South African gold mines by watering and medical supervision, was it brought home to us seriously as a malady, entitling to compensation, which we ought to tackle. A few of the names which will be remembered for pioneer work in this field are Watkins Pitchford and Mavrogordato in South Africa, Collis, Haldane, Middleton and Hall in Great Britain, and Chapman and Badham in Australia.

Fortunately, not all stone dusts cause silicosis. Limestone, Portland stone and oolitic stone, such as bathstone, are comparatively harmless. The more free silica a stone contains the more harmful will it be. Free silica would appear to be inherently wicked, by which I mean that it won't let the dust cell in the air vesicle of the lung, when trying to remove it, do its work. So obstructions to the channels of removal occur, they aggregate and become the starting point for the formation of fibrous nodules which, coalescing, diminish the amount of lung space available for oxygenating the blood. But this is not the worst thing that happens, for this damaged lung becomes a suitable soil for the development of the tubercle bacillus when it gets in. The terminal phase of the disease, generally after the twentieth to the thirtieth year of employment, is silicosis accompanied by tuberculosis.

Progress has been made in bringing this disabling condition under the Workmen's Compensation Act. Serious practical difficulties, to which I have already referred, led the Committee on Compensation for Industrial Diseases to recommend that the question of scheduling it should be kept in abeyance for the time being. In 1917 pressure was again brought to bear on the Home Office to deal with the subject owing to the success of the Miners' Phthisis Acts in South Africa. As a result a method was devised for dealing with the difficulties of the situation in this country by " schemes," each applicable to a particular industry or group of industries.

At present four schemes are in operation- the Refractories Industries Scheme, the Metal Grinding Scheme, the Various Industries Scheme and the Sandstone Industries Scheme. Perusal of the four schemes brings out what appears to be a strange inconsistency: those for the Refractories and Sandstone Industries embrace compensation for partial incapacity as well as for death and total incapacity, while the other two are restricted to death and total disability. The reason, of course, is mainly the burden placed on an industry by the payment of claims continued over a period of years in cases of partial disability, involving a levy perhaps of 5 or 6 per cent. on the wages bill from the employers in the particular industry. But, further, in these schemes a profound difference is to be observed in the way in which compensation is obtainable by the workman. Thus, in the two schemes with compensation for partial incapacity this is obtainable only through certification by a medical board, while in the other two compensation is obtainable through certification by the factory surgeon, with the usual

right of appeal, either by the employer or workman, to a medical referee. Now the unsuitability of the certifying factory surgeon for diagnosing cases that involve claims for silicosis is self-evident. It is not that he would not be right in most cases, but that he would never be sure that he was, since he has to make his diagnosis at a single interview (at a fee of 5s.) without the aid of an x-ray photograph. The Various Industries Scheme, which has just come into force, adopts the discredited rule of restricting compensation to death and total incapacity, whereas the Sandstone Industries Scheme, of a later date, handsomely expresses readiness to recognise partial incapacity as rightly entitling to compensation. To be fair one ought to say that the late Home Secretary was evidently aware of the Gilbertian quandary, and the appointment of the Silicosis (Medical Arrangements) Committee is a gallant effort at extrication.

Yet another scheme is in preparation—that for the Pottery Industry. The preliminary survey[3] by Drs. C. L. Sutherland and S. Bryson—members of the medical board appointed under the Refractories Industries Scheme—brought out the fact that of 72 elderly men exposed to unmixed flint dust 47 were found with fibrosis, and of 49 of those examined radiologically 23 showed silicosis. A similar survey by the same highly qualified medical men of their clinical examinations of 461 men (of whom 281 were radiologically examined) working on sandstones has recently been made. In this inquiry the examinations were confined to men employed at the time, no cases of persons already disabled being included, but relatively higher proportions were included of those who had worked for longer periods. The disturbing fact emerges that among masons, quarrymen, and wallstone dressers, about 50 per cent. showed positive evidence of silicosis radiologically. The critical period appears to be between twenty and thirty years of employment. A concluding statement in the latest report by Drs. Sutherland and Bryson is important as pointing to real prevention of the trouble by bringing an influence to bear external to the workman—that is, one over which he can exercise no control—namely, a very effective "device for the application of localised exhaust draught for removal of dust produced by pneumatic surfacing tools." This obviously means that a method has been discovered for utilising for this purpose the compressed air necessary in the work.

Silicosis is a world-wide problem, the extent of which has only been brought into prominence quite recently among the granite workers of Vermont, U.S.A., among the blasters, excavators and drillers of New York City, among the miners of Broken Hill and the tunnellers of Sydney in Australia, and on the Continent of Europe, so that the announcement which was made in March last of an international conference of experts to be held at Johannesburg in August, 1930, is to be welcomed.

[3] *Report on the Incidence of Silicosis in the Pottery Industry.* London: H.M. Stationery Office. 1926. 1s. 6d. net.

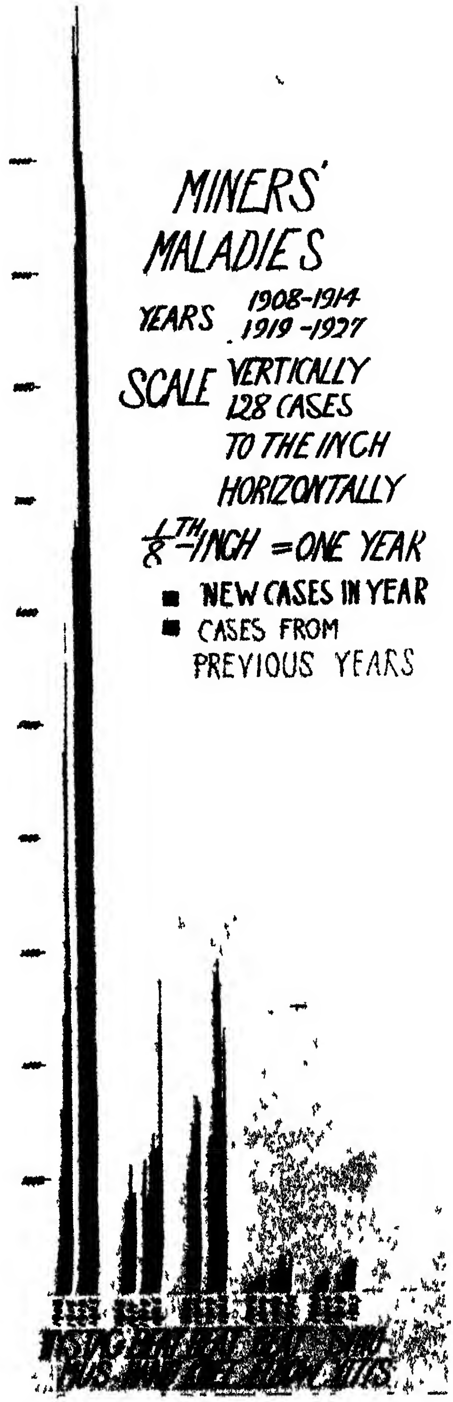
MINERS' MALADIES
YEARS 1908-1914 1919-1927
SCALE VERTICALLY 128 CASES TO THE INCH
HORIZONTALLY 1/8TH INCH = ONE YEAR
NEW CASES IN YEAR
CASES FROM PREVIOUS YEARS

CHART X.

Closely allied with silicosis is a somewhat similar condition which has been shown conclusively to be due to the inhalation of asbestos dust. Asbestos is the mystery mineral, crystalline yet fibrous so that it can be spun and woven like a textile material. It is a silicate of magnesium—a disconcerting fact, showing that it is not the presence of free silica alone which can give rise to fatal lung changes. Another mystery about asbestosis is also still unsolved. It is the presence, shown microscopically, in all fatal cases of curious golden yellow bodies, in relatively quite large numbers, not unlike, although they cannot be, the sporangia of certain moulds. These remarkable bodies were first described by Dr. W. E. Cooke,[4] Director of the Pathological Department of the Infirmary, Wigan. Asbestosis will have to be treated in the same way as silicosis for purposes of compensation.

I have given you an outline now of the principal maladies which I have had to deal with, and pass to another quite different group, the mining group - which accounts for so large a proportion of the claims—nystagmus and the acute infections, beat hand, knee and elbow. They have not, however, come within my purview, although I have read a great deal and heard a great deal of evidence about these maladies. All that I have heard confirms to my mind the view that miners' nystagmus is a vast neurosis in which auto-suggestion, unfortunately, cannot help but play an important part, due to the strain of working underground. And I am persuaded, too, by the evidence adduced by my predecessor in these lectures, Dr. J. S. Haldane, C.H., and that of Dr Llewellyn, working with him, that the remedy for it is to be found mainly in bringing an influence to bear external to the workman, namely, much better mine illumination Perhaps that will come through improvement in miners' electric caps, which, with the provision of an adequately designed fuse the latest report states, would make impossible any short circuiting of the battery. If a Government Department can ever be oppressed by the feeling of regret or remorse I cannot but think the Home Office must feel it in not having created a Medical Inspector of Mines many years ago. What could he not have accomplished!

[4] *Brit. Med. Journ.* July 26th, 1924, and Dec 3rd, 1927.

APPENDIX III.

"TWENTY YEARS' EXPERIENCE OF COMPENSATION FOR INDUSTRIAL DISEASES."

CASES OF INDUSTRIAL DISEASE FOR WHICH COMPENSATION WAS PAID.*

A—Cases continued from previous years.
B—Cases in which first payment made during year.

Disease.		1908	1909	1910	1920	1921	1922	1923	1924	1925	1926	1927
Anthrax	A	4	2	6	2	3	-	5	2	2	4	5
	B	23	22	35	26	8	28	19	23	25	26	20
Mercury Poisoning or its Sequelæ.	A	–		2					2	2		2
	B	3	1	2	2	3	4	1	3	4	5	1
Phosphorus Poisoning or its Sequelæ.	A											
	B	1	1		1			1	1	1		
Arsenic Poisoning or its Sequelæ.	A		2		2		1		6	3	2	1
	B	15	4	10	1	2	1	1	6	4	2	3
Lead Poisoning or its Sequelæ.	A	61	146	152	96	84	116	154	164	177	169	121
	B	421	351	367	169	146	157	236	285	231	177	154
Poisoning by Benzene and its Homologues, or the Sequelæ	A	–				–		1				
	B					6	1		1	2		
Poisoning by Nitro- and Amido - Derivatives of Benzene, and its Homologues, or the Sequelæ.	A		1	5			1	3	10	6	7	3
	B	10	8	28	52	9	20	46	23	18	17	27
Poisoning by Dinitrophenol or its Sequelæ	A							-				
	B				1			1	-	1		
Poisoning by Nitrous Fumes or its Sequelæ	A				2	–			2	2	1	1
	B	-		1	19	2	4	7	4	4	3	7
Dope Poisoning ..	A	-	—	-								
	B	-					1					2
Poisoning by Tetrachlorethane or its Sequelæ.	A	--	-	-								1
	B	--										
Poisoning by Carbon Bisulphide or its Sequelæ.	A										1	
	B		1		1	1			2			
Poisoning by Nickel Carbonyl or its Sequelæ.	A		-						1			
	B						1	7	2	16		
Poisoning by *Gonioma Kamassi* (African Boxwood) or its Sequelæ	A	-						1				
	B			1					2			
Manganese Poisoning	A										—	4
	B				-						4	
Dermatitis, from dust or liquids	A				13	30	24	45	72	94	125	133
	B		-		395	131	196	345	492	597	712	909
Ulceration of the Skin, from dust or liquids	A	1	5	4	12	10	7	11	6	18	14	8
	B	19	42	30	91	45	36	70	58	63	58	31
Ulceration of Mucous Membrane of the Nose or Mouth, from dust	A				1		--			1	1	
	B	-		-		1	1			1	1	3

Disease.		1908	1909	1910	1920	1921	1922	1923	1924	1925	1926	1927
Epitheliomatous Cancer, etc.	A	2	-	-	6	4	7	7	7	17	24	19
	B	5	4	4	16	19	14	15	12	49	85	55
Ulceration of the Corneal Surface of the Eye.	A		-		3	-	3	1	1	1	3	
	B			-	17		8	1		1	2	16
Scrotal Epithelioma (Chimney-Sweep's Cancer.)	A					2	1	1		2	2	43
	B	1	5	2	5	1	2	-	28	2	2	38
Chrome Ulceration or its Sequelæ.	A	1	-	10	4	12	4	11	10	9	5	7
	B	20	23	20	63	24	16	27	23	17	30	14
Compressed Air Illness or its Sequelæ	A	1	2	1		-	1		1	1		1
	B	10	2	2	1	2		2	3	16	9	
Cataract in Glass workers	A	-		1	1	2	1	1	1	1		1
	B			2	1	2	2	6	3	2	2	1
Cataract caused by Exposure to Rays from Molten or Red Hot Metal.	A							3	1	3	2	8
	B						12	7	9	8	8	11
Ankylostomiasis	A					-					1	
	B	6	8	7		1	1			1		
Miners' Nystagmus	A	74	380	662	4163	4804	5063	7273	7635	7890	8270	7934
	B	386	631	956	2865	1913	4092	3883	3271	3445	1771	1802
Subcutaneous Cellulitis of the Hand (Beat Hand)	A	28	20	32	47	54	82	110	103	81	109	298
	B	464	573	774	763	806	1183	1244	1137	1197	1151	2461
Subcutaneous Cellulitis or Acute Bursitis arising at or about the Knee (Beat Knee)	A	29	29	33	67	72	94	147	169	140	161	107
	B	539	881	1136	1322	896	1723	2640	2743	2603	1392	2202
Subcutaneous Cellulitis or Acute Bursitis over the Elbow (Beat Elbow).	A	8	6	2	14	11	13	36	19	15	31	12
	B	67	63	80	123	101	202	302	309	302	203	355
Inflammation of the Synovial Lining of the Wrist Joint and Tendon Sheaths	A		5	10	5	3	9	18	10	9	8	26
	B	87	128	95	75	78	186	192	190	204	174	253
Glanders	A		-									
	B			1								
Writers' and Telegraphists' Cramp.	A					-	1					
	B			1	3	2	2	2		1	2	2
Twisters' Cramp	A											
	B						1	1		2	1	
Inflammation, etc., of the Skin and Subcutaneous Tissues, due to Exposure to X-Rays or Radio Active Substances	A										-	-
	B											-
Silicosis (Refractories Industries)	A				7	39	64	115	138	147	194	234
	B				41	44	62	42	37	34	55	35

* In the published Statistics of Compensation for the year 1927 an error occurred in attributing 15 B cases to Dinitrophenol which should have been placed under Nitro and Amido derivatives of Benzene, and 1 old and 9 new cases to Manganese poisoning which should have been included under Dermatitis. This has been corrected in the Table above.

OBITUARY.

Lord Newlands, LL.D.—Lord Newlands, who died on September 5th, at the age of 78, at Barrowfield Lodge, Brighton, was elected a Life Fellow of the Society in 1912, and served as a Vice-President and Member of the Council for the period 1915-17.

James Henry Cecil Hozier was born at Tannochside House, Lanarkshire, in 1851, and was educated at Eton and Balliol College, Oxford. After serving in the Foreign Office from 1874-8, he became Private Secretary to the Marquess of Salisbury, when Foreign Secretary, from 1878-80, and again, when Prime Minister, from 1885-6. For twenty years (1886-1906) he sat as Conservative M.P. for South Lanarkshire, when he succeeded to the barony on the death of his father, the first Lord Newlands.

Lord Newlands took a deep interest in education and philanthropy. In 1907 he presented a large sum of money to Balliol College to found the Jowett scholarships and in the following year he also founded the Newlands scholarships. He was elected an Honorary Fellow of the college in appreciation of his gifts. His name was also associated in many directions with philanthropy and public service in Glasgow and Lanarkshire. As President of the Territorial Force of the county he supported every movement for the national weal, especially after the outbreak of the Great War, devoting himself unsparingly to the raising of troops, the collection of relief funds and the alleviation of suffering. He endowed the Lady Hozier Convalescent Home in Lanark in memory of his mother, and made various gifts of recreation grounds and open spaces.

He was Lord Lieutenant of Lanarkshire from 1915-21, a Public Works Loan Commissioner since 1900, and a Brigadier in the Royal Company of Archers, the King's bodyguard for Scotland. In 1917 he was made a freeman of the city of Glasgow, and he also received the degree of LL.D. from Glasgow University.

NOTES ON BOOKS

The City of To-morrow. By Le Corbusier. Translated by F. Etchells. Rodker, London. 25s.

M. le Corbusier is to town-planning what Prince Kropotkin was to agriculture. He is a very important person. He is putting forward proposals which may seem startling to-day, but which will have been adopted and taken for granted to-morrow. People will be as amazed in 2030 to think that the nineteenth century could have tolerated slums and jerry-built suburbs, as we are to-day when we are reminded that in the eighteenth century men were hanged for stealing a sheep.

M. le Corbusier is not an impetuous youth. He is an experienced practising architect, who has succeeded in imposing his ideas, his houses—not yet his city—on a number of European municipal bodies. He has already gone far. He is no longer "playing a lone hand." He is to be found on committees. He is followed by some architects, imitated by others. It is recognised by a respectable minority that he is equipped with the sort of brains and vitality that serve reason in the battle against prejudice.

Urbanisme, here admirably translated by Mr. Etchells, is singular both for its content and its expression. Though the author says that "nothing is going to make a politician" of him, providence made anything but a pure and simple architect of him. He is philosophically inclined; his mind seethes with general ideas. Happily one of these is that enunciated by Pythagoras. "Man is the

measure of all things." This is why M. le Corbusier's sky-scrapers are going to be unlike the sky-scrapers of New York.

The author's jottings have a Leonardesque variety; they also suggest Vachel Lindsay. And if from time to time M. le Corbusier carries us with him to the peaks of his vision, he soon bumps us down gently but firmly on a table of statistics. Appended we find notes by a civil servant, one of a class from which purple patches are not to be expected.

Critics have found that shafts aimed at the master are apt to recoil against themselves. A gentleman, discussing *Vers Une Architecture*, wrote: "Is the next generation really destined to pass its existence in these immense geometrical barracks . . . conveyed at the same hours by the same trains to the same sky-scrapers?" M. le Corbusier, having dealt with the objection to geometrical design, rounds amusingly on the journalist. "You are not going to make me believe," he says, "that up to the fatal moment when my book was published trains started at any old hour, arrived when they liked, and once they arrived were broken up and burnt, so that other trains could be employed the next day!"

M. le Corbusier is clearly right in maintaining that we suffer to-day not so much from Order as from Disorder. It is a feeling of the uncertainty of life, not its monotony, that weighs so heavily on our urban populations. The monotony is there, too; and M. le Corbusier believes that the Order which he proposes will give contemplative satisfaction as well as a new stability to our civilisation. We cannot rely solely on education to provide a higher plane of understanding for all and sundry. Education, culture, is strangled in its infancy if opportunities for expression are lacking. The plight of educated men and women under hopelessly unpromising conditions is worse than that of phlegmatic barbarians.

Opportunities depend in the first place on the right organisation of the fundamental necessities of life: Kropotkin's province. In the second place they depend on the right organisation of the human environment: M. le Corbusier's province. Efficiency and hygiene must not be confused with culture, as they sometimes are in Anglo-Saxon countries, but at least they are the second best thing, and, in the long run, a means to the higher end, as well as being an end in themselves. M. le Corbusier's idealism is never *naïf*; he does not exasperate the honest sceptic with anticipations of a humanity that has been reformed by him. It is the external world that he wants to reform; afterwards perhaps humanity will find it easier to reform itself.

Kropotkin drew up a scheme for the intensive cultivation of the soil. M. le Corbusier's City of the Future is also a matter of intensiveness. The business quarter of the City is to consist of sky-scrapers sixty storeys high. This quarter is to be at the heart of the City, the actual centre of which will be an air port and railway station. Now the only advantage of sky-scrapers is that they may be used to relieve congestion, and so make it possible keep even the busiest part of an urban area open to sun and air. By far the greater part of M. le Corbusier's City is made up of open spaces, laid out as gardens and planted with trees. The sky-scrapers represent intensive building at those points where most work can most conveniently be done. By concentrating the different categories of traffic on different superimposed levels, immeasurably greater facility of communication than now exists will make any attempt to encroach upon the open spaces unthinkable.

In this book the plans for the City are worked out in some detail, and economic considerations are dealt with, though more briefly. There is a chapter at the end describing what is called the "Voisin" plan for the rebuilding of an overcrowded and slummy region in Paris, and its harmonisation with the work of Haussmann and the great eighteenth century architects.

The subject, and M. le Corbusier's treatment of it, are of the profoundest interest. For the limited progress in which reason allows us to believe depends for its realisation on deliberate human action directed to definite ends. Tolerable working conditions having been secured, there remains to be dealt with that problem of the employment of leisure which has got to be solved for the millions before any industrial country can become really civilised. The more that working hours are reduced, the more necessary will it be to secure for all cheap art and cheap exercise. This is as obvious as the superiority of trial by jury to trial by battle, but unfortunately bad systems have a way of lingering on.

It will be seen that if ninety per cent. of the area of a city is open space, there will be no difficulty about providing play grounds for children and sports grounds for adults. Little boys in back streets would no longer have to play their precarious cricket under the wheels of lorries, amid dust and dirt. The average health of the community would go up. The demons of smoke and noise having been exorcized, city life would recover an element of reposefulness, without which it has in the last twenty-five years become intolerable.

England must not postpone designing her Cities of To-morrow. Already a wise Bill for the regulation of town-planning has been prepared for the French Chamber, a Bill that shows traces of M. le Corbusier's growing influence. P. B.

THE COUNTY ANTHOLOGIES. (1) Yorkshire. By G. F. Wilson. (2) Derbyshire. By Thomas Moult. (3) Lanarkshire. By Hugh Quigley. London: Elkin Mathews and Marrot, Ltd.

Messrs. Elkin Mathews and Marrot have been happily inspired in planning this series of anthologies of which the three above mentioned have now been published. Each volume will contain an anthology of prose and verse devoted to one particular county, and its preparation will be entrusted to a well known man of letters with a special interest in that county. While the anthologies will appeal to the general reader, they are intended primarily to have an educative influence on boys and girls, and to foster in them an appreciation and love of their native surroundings. As Professor Cowl, the general editor, writes in the preface to "Yorkshire": "For the young a literature that invests with imaginative beauty familiar scenes and objects may prove to have a more compelling appeal than the wider literature that treats of things remote from their experience and sympathies." Charity is not the only thing that begins at home. The boy who has learnt to appreciate the beauties of his native village and his native county should be able to extend his appreciation to the beauty of his native land and soon until he can understand and love beauty wherever it may be. With this end in view it is hoped that each anthology may find its way into the schools of the county with which it deals, and accordingly the volumes are issued in three forms: one at 2s. 6d. for schools and classes, and two more luxurious at 3s. 6d. and 6s. net.

The three volumes before us, sponsored as they are by literary men of standing, are all admirable, and the selection of pieces most discriminating. The Derbyshire boy who reads Michael Drayton's "The Wonders of the Peak," the Yorkshire lad who reads his "Most Renowned of Shires," should feel a fresh pride in his county. It was never more necessary to inculcate love of our matchless countryside than now, when it is threatened by a thousand dangers, and if these anthologies do their work as they should, in the rising generations we should find plenty of support for schemes for the preservation of rural England, and for such enterprises as the Royal Society of Arts has undertaken in the saving of our most beautiful old villages.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICE.

HISTORY OF THE ROYAL SOCIETY OF ARTS.

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15s net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

NOMADIC MOVEMENTS IN ASIA.

By Sir E. Denison Ross, C.I.E., Ph.D.,
Director of the School of Oriental Studies,
and Professor of Persian, University of London.

Lecture I.- THE ARABS.

(*Delivered April 22nd*, 1929).

The four nomadic movements which form the subject of these lectures extend over a period of roughly 1,000 years. The first is the sudden exodus in the VII Century of the manhood of Arabia from their deserts and their rare towns into the lands of the Byzantine Emperors, and of the Chosroes of Persia. The second movement is that of the Turks, who, in the VIII Century, began

to migrate in a westerly direction from their habitats in Mongolia and Northern China. The third movement, namely, the penetration of Middle Asia by the Seljuks in the XI century, is, of course, only a corollary to the second: while the fourth, the most extensive of all, is that of the Mongolians under Chingiz Khan and his sons and grandsons in the XIII century. The period of time which elapsed between the exodus of the Arabs and the Mongolian invasion of Asia and Europe, of course, witnessed many other big movements of armies in Asia, but none of these can, I take it, be characterised as migrations of peoples: for these expeditions usually returned by the way they had come, whereas the Arabs, the Turks, and the Mongols established themselves as far as they were able wherever they penetrated by conquest, and had *no thought of returning to their original homes.* The Arabs and the Mongols, it is true, remained in close touch with their mother countries as long as they were able, but the early Turks and the Seljuks as it were carried their homes with them in a wider sense than the purely nomadic. If we consider the conquests of later Turks, such as those of Mahmud of Ghazna, in the X-XI century, of Muhammad the Khwarazm Shah in the XII, or of Tamerlane in XIV XV, we shall notice that, although they resulted in the temporary establishment of vast empires, they were rather in the nature of military exploits by organised troops than of nomadic migrations, and that these leaders invariably returned to their head-quarters at the termination of a successful campaign.

The case of the conquest of Upper India by the Mughals under the Emperor Babur, himself a Turk, offers peculiar features: for here we find a conqueror with an organised force setting up a new kingdom in a foreign land--a land inhabited mostly by Infidels - and founding a dynasty which became essentially Indian. There is no question of a Turkish Court at Delhi or of Turkish settlements in Hindustan. The Turkish troops under Babur seem to have left no more mark on the population of the Panjab than those under Mahmud of Ghazna (who invaded India no less than 14 times) or of Tamerlane who raided Delhi. It is in view of such considerations as these that I would claim a distinct place in history for the four movements which form the subject of my lectures.

There is in these lectures what I may call a quite unintentional unity of action, seeing that the Arabs encounter the Turks: that from these Turks spring the Seljuks: that the downfall of the Seljuks facilitated the invasion of Persia by the Mongols.

It is interesting to picture to ourselves the immediate effects of such wholesale invasions as we are now considering, in contradistinction to the passage through the country of a military invader.

As an example, we may take it that the occupation of N.W. France by the Norsemen was an immigration, whereas the conquest of England by the descendants of these Norsemen was a military invasion. One part of France became Norman and has remained so ever since: no part of England became Norman any more than India under British rule becomes English.

The Exodus of the Arabs.

In order to give you a picture of this great exodus of the Arabs, I fear I cannot avoid referring at some length to the career of the Prophet Muhammad and to the foundation of Islam as a religion, and this will necessitate the repetition of many incidents with which most of you are, I am sure, already familiar.

For, in order to understand the true significance of the Arab invasions, we must realise what it was that led to the creation of a united nation in arms out of the unpromising material offered by the scattered Bedouins of the desert, whose only common bond was a vague fetishism. The Bedouin also had the tie of kinship which attached him to one or other of the great desert tribes: but his main characteristic was his love of independence. It is difficult for those who have not seen the lonely Arab in his desert to picture what this independence means. We are so apt to think of the Bedouins in terms of encampments, of large tribes wandering about with their flocks and tents in search of pasture or water. This picture has been made more familiar in recent times, thanks to the cinema and its ridiculous idealising of the *sheikh*.

Arabia, as we know her to-day, has no rivers, and her towns are few and far between. Three-quarters of her natural frontier is formed by the sea-coast. The rest of her frontier, extending from Akaba to the confines of Mesopotamia, is in desert land. In remote times, Arabia, according to the geologists, presented a very different picture and possessed streams and consequently pasturage. But, as has so often happened and as still happens to-day in countries where sand is prevalent, the desert has constantly eaten up the sown and finally dried up the rivers. This process of desiccation it was that led in the past to the migration of the inhabitants of Arabia, who were of Semitic stock, northwards into Syria, Palestine, Mesopotamia, and Babylonia. And thus probably originated those great cultural nations, the Assyrians, the Babylonians, the Arameans, the Syrians, and the Jews, who left behind them so great a heritage of literature and art.

I do not think either geologists or historians are prepared to give a date for these migrations, which did not probably all take place at one time. But it would seem that by the end of the sixth century the inhabitants of the Arabian peninsula had again so greatly increased, and the resources had again so greatly decreased, that the Semitic people—who now called themselves Arabs—were beginning to move northward, forming the Arab population of Syria, which under the Byzantine Emperors accepted Christianity.

We must not forget the close connection that exists between the character of the Arabs and the physical conditions of their land and of the Arabian desert in particular.

For us who have always lived in temperate regions, where the climate is mild and victuals are cheap and abundant, and where life is easy and secure, it is difficult fully to appreciate what a man's life is like in a country where

for more than eight months of the year the heat is asphyxiating by day and where in the winter the cold is intense by night, food is scarce and water a precious rarity, and any form of government is totally lacking, so that the life of every individual is in constant danger, either from nature or from man.

Only he who has journeyed in the desert can understand the terrors, the dangers and the suffering which these cruel solitudes impose on mankind, solitudes in which to go astray means certain death from thirst. Mere words cannot but fail in an attempt to describe the desert with its fearful summer heats, its immense stretches of burning sand, its rocky hills and plains, brought to a white heat by the implacable sun, where in summer every inch of ground burns so that it is almost unendurable to the human touch.

Of course there have always been among the Arabs townsmen and dwellers in the oases whose lives in general were very much like those of any other settled population in the East. But it is the life of the Bedouin nomad that offers us such a strange picture- I do not think it is commonly realised that the desert is largely peopled by small groups of wandering families, with small mixed flocks, who have *no home* to go to at any time, and who many of them never sleep under a tent. And in the desert the cold is at certain seasons as severe as the heat of the sun in the summer.

The wonder is that any race should have been found which was willing to endure all the hardships involved by such a life: and that the causes which led to the emigration of the other Semitic peoples did not compel this branch also to abandon Arabia when this once smiling and fertile land began to dry up.

In any case the Arabian Bedouin of the time of the Prophet knew of no other life and no other conditions than those of the desert: and long generations before them had learnt to resign themselves to what they considered the inevitable, and had developed those peculiar characteristics which fitted them to this strange and apparently aimless life. Though the Arab of those days was illiterate he had one element of culture strongly developed, namely, his love of poetry, and among them no man enjoyed such high prestige as a recognised poet, whose glory redounded to the honour of the whole tribe to which he belonged.

With the rise of Islam this gift gradually disappears—partly no doubt because Muhammad had a special dislike for poets—and although the Arabs quickly took to learning and letters after they had been brought into contact with the cultured nations they had conquered, there was no survival of real Bedouin poetry—only artificial imitations quite lacking in inspiration. The designation Arab as applied by us to-day to Literature and Art—except for this Bedouin poetry—does not mean the Arabian, but the product of that merging of the descendants of the early Bedouin invaders with the cultured races of the Near East and Middle East.

Let me now pass to a rapid survey of the rise of this new religion.

At the beginning of the seventh century the Yemen and part of the Hadramaut

were in the possession of the Persians, while the Syrian frontier was ruled over by the Gassanids under the suzerainty of the Byzantine Emperor. The whole peninsula was inhabited by Arabs, but the Hejaz contained large Jewish colonies which had been driven out of Palestine. Some of the Arabs were Christian, but the majority were heathen. They believed in a supreme God called Allah, who had created and who ruled the world. He had no temples in his honour and no priests to serve him. Next to Allah came the jinns who had fixed habitations in stones, trees or statues. Each Arab tribe had its special jinn or jinns Mecca was the principal religious centre of Arabia, and possessed an old temple called the Ka'ba—or Cube—round which the tribe of Kuraysh had built a city in the fifth century of our era. The Ka'ba did not belong to the Kuraysh but was the common Pantheon of many tribes and contained three hundred and sixty idols. The most sacred object it contained was the Black Stone, which is still venerated by the Muslims. Hence the importance of the city of Mecca and of the tribe of Kuraysh which had the guardianship of the Ka'ba. The Arabs had no belief in a future life, and their religion was little more than a degraded fetishism

Early in the seventh century there suddenly appeared an Arab named Muhammad, of the tribe of Kuraysh, inspired with the idea of reducing the number of Arabian gods to one, and of compelling his fellow countrymen to recognise his mission as divine The new prophet being a townsman and a merchant, whose business had taken him into foreign countries, had often had opportunities of meeting Jews, Christians and Zoroastrians. Islam owed much of its success to the fact that so large a part of its doctrines was derived from these three great religions. The Prophet is instructed by God to say "I am no apostle of new doctrines, and I do not know what will happen to me or you. I follow naught save what has been revealed to me. For I am only a public admonisher."

The pagan Arabs had no "book" and very few monuments. Other nationals with whom Muhammad came in contact had a "book" and temples, but they had no idols. It is possible that Muhammad, impressed by the feeling that in these respects the Arabs were inferior to their neighbours and that idols were undignified, determined to provide his fellow countrymen with a "book" of their own and to exterminate all the gods but one. But in order to justify the preaching of a new religion he must prove its superiority to all others and try also to convert to his way of thinking the Jews and Christians. He was determined to make Islam the one religion of the Arabian Peninsula. He was, however, unable to satisfy either the Jews or the Christians, and thus one of his first objects was to turn the Jews out of Arabia. In connection with his relations with the Jews there is an infallible way of remembering the relative positions of Mecca and Medina. In the first instance, the Prophet instructed his followers to turn towards Jerusalem when saying their prayers. When he quarrelled with the Jews he reversed the order, and told the Muslims

to turn towards Mecca. For the people of Medina this meant *exactly the opposite direction.* His feelings against the Christians as such were no doubt somewhat modified by the fact that the Christian King of Ethiopia gave sanctuary to many of his persecuted followers who had fled across the Red Sea. This same circumstance may possibly account for the fact that Abyssinia was never invaded by the Arabs.

Muhammad, the son of 'Abdallah, the son of 'Abd-al-Muttalib, the son of Hāshim, the son of 'Abd Manāf, is said to have been born in A.D. 571. Of his early life down to the age of forty we know very little. At the age of twenty-four he married Khadīja, widow of a rich merchant in whose service he had made caravan journeys into Syria and South Arabia. By this marriage Muhammad had six children, of whom we need only mention the youngest daughter Fātima. After the death of Khadīja he married a young girl called 'Ayesha, the daughter of Abu Bakr.

About the year A.D. 610 Muhammad, who was given to solitary wanderings, one day had a dream in which it seemed to him that someone said to him : " Recite in the name of thy Lord who created man—and teaches man by the pen what he does not know." Muhammad was deeply impressed by this dream, which may be regarded as the beginning of his mission.

Thereafter he began to receive these dream messages with recurring frequency, and they were recorded or remembered by Muhammad as the Word of God delivered to him by the Angel Gabriel. Thus was created what came to be known as the Koran, or " the reading," which was only brought together after the Prophet's death. It should always be remembered that the Koran contains not the words of the Prophet, but the Words of God. All quotations begin : " God said—" not : " Muhammad said."

The whole of his family, including his adopted sons 'Ali and Zayd, and many of his intimate friends immediately believed that Muhammad had received a divine mission. The most important of these friends was Abu Bakr, a wealthy merchant who belonged to the tribe of Taym. The complete faith which this honourable man placed in Muhammad and his mission was not only an invaluable source of encouragement to Muhammad, but is a most important testimony to the genuineness of the Prophet's mission.

His uncle, Abu Tālib, became his chief supporter. Though only a poor man, he enjoyed the highest respect of all the Hāshimites, and whilst he lived no one would dare to attack Muhammad.

Not all the Kuraysh, however, were prepared to follow him, and the most notable opponent was another of his uncles, Abu Lahab, who was consequently condemned in the Koran to hell fire.

Another Kurayshid follower was won by his marriage with two of Muhammad's daughters, namely, 'Othman, of the family of Omayya. In all, the first band of the faithful are said to have numbered forty-three persons. Among these were several slaves, and mention may be made of an Ethiopian

named Bilāl, who, by reason of his loud voice, became the first *Muezzin* to call to prayer in Islam. The whole Muslim confession of faith is contained in the words: "*There is no Deity but Allah, and Muhammad is the Prophet of Allah.*"

By day the Prophet preached to the people, and by night he received revelations, which often had bearing on current events. Muhammad knew no half measures; and the name Muslim, applied to believers, is derived from the word *Islam*, which means "total submission to the will of God."

The public feeling against the new religion often took an active form, and the Muslims were mocked and persecuted. Indeed, they were soon obliged to hold their meetings in a private house. But the turning point in these first years of the mission was the conversion of 'Omar, the son of Khattāb, who had hitherto been one of the strongest opponents of Islam. This young man of twenty-six already commanded so much respect among his townsmen for his bravery and decision of character that from the day of his acceptance of Islam the Faithful were able to perform their prayers in public. The importance of the role played by 'Omar in the history of Islam cannot be overrated. It was he who spurred the Prophet on to action, and encouraged him to undertake the conversion of all Arabia; and to resort to force of arms where peaceful methods failed. It was 'Omar, moreover, who initiated the invasion and conquest of the outer world by the Arabs.

Towards the end of A.D. 619 two great misfortunes befell the Prophet. Within a few weeks he lost first his faithful Khadīja, to whom he had been married for twenty-four years, and then his uncle and staunch defender Abu Tālib, who enjoyed such respect in Mekka that no one dared to attack his nephew. On the death of Abu Tālib, Muhammad's position in Mekka became one of such grave danger that he was, we are told, afraid to leave his own house. He was peremptorily ordered to give up his public preaching, and to cease from attacking the idolatry of his compatriots. In the meantime, however, during the annual pilgrimage which brought Arabs from far and near to Mekka, he had succeeded in converting a number of pilgrims to the New Faith, and notably some inhabitants of the town of Yathrib. With them he formed a secret alliance in A.D. 620; but no sooner was it noised abroad that he had thus betrayed his own home and his tribe, than further residence in Mekka became impossible for him. He therefore resolved to migrate to Yathrib and seek the protection of its inhabitants; but the number of converts he had succeeded in making during the pilgrimage was not sufficient to guarantee the support of the whole tribe. In A.D. 622 a secret meeting was held during the last days of the pilgrimage, between the Muslims of Mekka and the envoys from Yathrib; as a result of which the former migrated to the latter city, where they were received with open arms by the local converts. The last to leave Mekka were the Prophet himself, Abu Bakr and 'Ali: it is from this event—known as the *Hijra, i.e.*, the

migration or flight of the Prophet—that the Muhammadan era dates. The town of Yathrib, to which Muhammad fled, now received the name of al-Medīna, which means "the city *par excellence*." He found Medina ready to receive him, and it remained his headquarters for the next ten years; for he did not capture Mekka until just before his death.

During these ten years the Prophet was constantly engaged in warfare and in bringing the people of Arabia to obedience. He was determined to make the new religion the religion of the whole peninsula, and by the time of his death, in 632, he had practically achieved his purpose.

When Islam was carried outside Arabia as an established religion, the Muslims were more tolerant, and, apart from the risk of eternal damnation, the conquered peoples had only to choose between Islam and the payment of an annual fine.

Whatever opinions we may hold regarding the message of the Arabian prophet, we may rest assured that Muhammad always had complete faith in himself. It would be difficult to imagine any man starting on such a career as his at the age of forty for other than a spiritual motive. Whether Muhammad at the outset conceived the idea of making Islam a universal religion—and texts have been quoted from the Koran to show that he did—is still a matter of debate, but he certainly could not have entertained any thoughts of temporal leadership, still less of sovereignty over all the Arabs. During the ten years of the Prophet's life that remained to him after his flight to Medina he took part in no less than twenty-seven battles and organised forty-seven expeditions. It may be imagined, therefore, that he cannot have had much inclination to think of converting the outside world. Tradition speaks of letters addressed by Muhammad to the Byzantine Emperor and to the Chrosroe of Persia, demanding their acceptance of the new faith, and a force of some size for a punitive expedition over the Syrian frontier had been collected in Medina just before the Prophet's death; but beyond this there is nothing recorded which points to a determined propaganda outside Arabia. Muhammad gained his lordship over the Arabs by force, and while his devoted generals were wielding the sword on his behalf, he himself was laying the foundations of the faith which, though it at first found so little favour in Arabia, was ultimately to be accepted by peaceful preaching in so many countries outside the Prophet's own land. We may take it that the Arabs as a whole felt very little drawn towards either dogmatic beliefs or ritual practices. This indifference was largely responsible for the intransigeant form given by the Prophet to the creed he preached. But propaganda in the truest sense only makes its appearance in Islam in connection with the parties and sects that arose among the Muslims; factions which, though bearing a religious semblance, were purely political in aim, such as propaganda of the 'Abbasids in Khurasan, of the Fātimids in Egypt, and of the Ismailis in Persia. Behind most of these movements,

notably the great schism between the Sunnis and the Shi'as, lie the disputed claims of inheritance. It is interesting to recall that no such questions were at the back of Christian schisms, which were all dogmatic. Whereas these arose on questions which had reference to the preaching of Jesus Christ, Islamic schisms nearly all related to the question of succession to the Caliphate, on which Muhammad has made no pronouncement at all.

The hold of the new faith over the Arabs was of the slightest, and it is highly probably that if chance had not at an early stage filled the Muslims with a desire for foreign conquest, the whole of Arabia would have reverted to its original state. For the Arabs above all love independence, and the Bedouin resents all forms of control and authority beyond that of his tribal chief, and that sits lightly enough.

It was the civil war necessary for the conversion of the Arabs which gave the warlike character to Islam, and it was the successes of Muslim generals like Khālid ibn Walīd which tempted the faithful to try issues with foreign nations.

The battles in which the true believers were during ten years so constantly engaged against their fellow countrymen, were never on a very large scale—but they did suffice to make the fame of a number of capable commanders, and to give the Arabs as a whole more experience in warfare than they were in the habit of deriving from their inter-tribal feuds. We can imagine that they now wanted to turn to advantage the experience they had thus gained and try issues with the Arabs over their frontiers. The very first movement of this kind was a raid led by certain hot-headed men into Transjordania, where they came into collision with Byzantine troops by whom they were utterly routed at Mūta. It is more than likely that the Prophet would immediately have followed up this defeat by an expedition of revenge into Syria, but he was at that moment engaged in the important task of capturing the town of Mekka. When in 631 he at last achieved this he assembled a huge army and set out towards Syria to avenge the slaughter at Mūta. He did not accompany the expedition very far as his presence was needed in Mekka, and in the following year he died and the expedition was abandoned. Muhammad died without appointing a successor; and this may be accounted for by the fact that he did not realise that he had founded not only a new religion but also an empire; that he was not only the Prophet of God and Islam, but had also become virtual king of Arabia. There was much discussion after his death regarding a successor, and finally his old and trusted friend Abu Bakr was appointed Khalīfa or Caliph. He only survived for two years, but in these two years he initiated the first stages of the conquest by the Arabs of the outer world. The first task which lay before Abu Bakr was suppressing the revolutions which followed the death of the Prophet. Three different pretenders arose in various parts of the Peninsula and laid claim to the Prophetic office, and it is noticeable that these rebellious leaders never posed as princes or kings, but only as rival

prophets. It was the courage and firmness of the aged Abu Bakr which saved Islam at this crisis. One Muslim historian writes:—"On the death of Muhammad it wanted but little and the Faithful had perished utterly. But the Lord strengthened the heart of Abu Bakr, and established us thereby in the resolve to give place not for one moment to the apostates; giving answer to them but in these words: 'Submission, Exile, or the Sword."

In 633 when Abu Bakr had managed to bring back to the fold the recalcitrant Arabs, he was faced with the problem of a country full of trained men who were a positive menace to peace. As a solution for this difficult problem he decided to send thousands of these men over the northern frontiers with promises of loot such as they had never dreamt of. I do not think either he or anyone else then thought of conquest on an extensive scale; it could hardly occur to them that they would so soon find themselves in Cairo and Khurasan. He dispatched two armies towards Iraq; one of these armies under the famous Khālid is said to have numbered 20,000 men.

The first battle fought took place at Hafir and was known as the Battle of the Chains, because some of the Persian soldiers are said to have been bound together with chains to prevent their running away. Khālid, who began the engagement by slaying the Persian satrap in single combat, gained a decisive victory over the enemy and was able to send vast booty to Medina.

At this time Bedouins were fighting on both sides and the famous tribe of Bakr was about equally distributed. The intense cruelty of Khālid towards the prisoners aroused bitter feelings on the part of the non-Muslim Arabs. Otherwise it might have been possible for him to advance at once against the Persian capital Ctesiphon. He, however, first directed his march towards Hīra, on the Euphrates, which capitulated, and here was concluded the first treaty between the Arabs and a foreign power. Hīra, in which Khālid remained for one year, was the first foreign town of importance to be occupied by the Muslims.

A third army meantime had been despatched to Syria under a leader also named Khālid, who, though he had better troops, could not be compared with his namesake in generalship. In his first encounter with the Byzantines Khālid fled and Abu Bakr now despatched a strong force in four detachments numbering, we are told, between 30,000 and 40,000 men. They concentrated at a spot on the river Yarmuk, which falls into the Jordan below the lake of Gallilee. For some time desultory fighting occurred, but the four leaders were unable to come to an agreement on a joint attack, and feeling that what was needed in this great emergency was a unity of command, Abu Bakr recalled the other Khālid from Iraq and placed him in command of the Syrian army. In the battle which ensued the Byzantines were totally defeated and the fate of Syria was sealed. The Muslims are said to have lost three thousand men, while the Byzantine losses are estimated at over a hundred thousand. This large figure is to be mainly attributed to the fact that the Greeks were hurled over a yawning gulf which lay immediately in their rear

In 634 Abu Bakr died and was succeeded by 'Omar, who had already played such an important part in the rise and progress of the new religion. In 635 Damascus fell. In the following year Heraclīus abandoned Syria. In the great victory of Qadisiyya in 637 the Arabs drove the Persians out of all their western possessions and became masters of Iraq, including the then capital Ctesiphon, where the Persians offered stubborn resistance. Progress from now on was so rapid that within twelve years of the Prophet's death the Arabs, marching north, east and west, had acquired territory as large as Germany and Austro-Hungary before the war Thus did the unlettered Bedouins, with no government and no discipline beyond the loyalty to their chiefs, conquer highly civilised peoples ruled by kings of ancient lineage and by a highly efficient bureaucracy.

It is not my object in this lecture to enumerate the battles won or the lands conquered by the Arabs in their triumphant progress East and West, but rather to help you to understand the political conditions and other circumstances which brought about this sudden exodus from Arabia at the beginning of the seventh century, and rendered possible their victories The fundamental causes of this movement may have been, as I have said, partly economic: they were certainly in a large measure political, and ostensibly they were wholly religious But although the Muslims had a *slogan* or war-cry, one cannot help feeling it was their love of fighting and of loot that was their strongest impetus: for the clearly-defined conditions of conquests which they adopted go to show that their main objective was the occupation of fresh territory.

One can well imagine the astonishment of the Byzantines, the Persians and the rest when they discovered that these unlettered men in addition to their swords and spears had a new religion which was made their excuse for invading the world Surely no other victorious army in history has ever insisted on spreading a new religion. And surely no other religion has ever been first preached at home and abroad at the point of the sword.

It has been suggested by some writers that it was the friendly attitude of the Semitic peoples in Syria and Iraq which changed the original plan of using the trained men of Arabia for simple raids across the frontier into one of conquest. "Among the shrewd companions of the Prophet at Medina, the idea speedily gained ground that instead of the precarious adventure of such raids from which only those engaged in them would benefit, and which would only leave destruction in its train the friendly attitude of the indigenous population, who had no reason to love their rulers, whether Byzantine or Persian, now made it possible to turn the ephemeral gains of an expedition into a permanent and secure source of revenue to the newly-founded state of Islam. It was therefore these Semitic subjects of Christian and Zoroastrian rulers who really turned the Arab raiders into conquerors--and not only did they offer no resistance except under compulsion—but they rendered practical

assistance to the Muslims by acting as spies and by offering their services in the administration of the new state."

Our only sources of information are those of the Arabs themselves, and it is quite natural that their chronicles should maintain a discreet silence on any factors in the story which tended to diminish the glories of the conquest.

We at any rate know that on the whole very little opposition was encountered while the expeditions of the Muslims were confined to Semitic lands. Only Caesarea in Palestine and Ctesiphon in Iraq offered really strong resistance. The task of the invaders became more difficult when they came into conflict with non-Semitic populations.

In view of the comparatively sparse populations of the Peninsula the number of the Moslem troops engaged in these early conquests cannot have been very large: but new recruits would be constantly arriving, and after a quarter of a century had elapsed from their first exodus, there were doubtless thousands of young Muslims ready to take up arms whose mothers were of non-Arab origin.

Another important factor of the success of the Muslims was the good treatment meted out to all who submitted without resistance.

The conditions of conquest were clearly defined. Where the population submitted without any show of opposition, they were allowed to retain their own religion and to continue in possession of their lands: all that was required of them was the payment of a capitation tax which was considered to be the price they paid for the protection they received from the conqueror.

Where, however, armed resistance was offered and force had to be employed the Muslims claimed the right to pillage the country, kill the men and make slaves of the women and children. Of course any one who wished to turn Muslim was at once admitted to the fold on pronouncing the simple formula of Islamic faith. According to the prescriptives of the second Caliph 'Omar every Muslim was a soldier of Islam who might at any moment be called upon to defend the faith, and was entitled to pay for services rendered.

The Muslims were forbidden to acquire land, and received payment either in money or in kind which was derived either from the tax on the conquered or from loot. The old division of the Arabs into tribes was still continued, with its concomitant internecine quarrels and its *vendettas*. The conquered peoples cultivated the soil, the Muslims lived on the produce and had no occupation but that of soldiers.

One can readily believe that the conditions of life in these new surroundings did not fail to have a demoralising effect on these Arabs of the desert, and that in the course of time those who settled in towns became luxurious and effeminate. Where the population becomes settled tribal solidarity and tribal loyalty tends to disappear.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

COMPETITION OF INDUSTRIAL DESIGNS.

LOCAL EXHIBITIONS.

The Exhibition of industrial designs at the Imperial Institute, which was viewed by a large number of visitors during the month of August, closed on September 1st. Arrangements were made this year, as on several occasions in previous years, for holding local exhibitions of particular sections of the designs in provincial centres after the termination of the Exhibition in London. Two such local exhibitions were arranged this year: an exhibition of the china and earthenware designs and exhibits from September 16th to 30th at the Burslem School of Art, and an exhibition of the glass designs from September 23rd to 25th at the Wordsley School of Art.

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

NOMADIC MOVEMENTS IN ASIA.

BY SIR E. DENISON ROSS, C.I.E., PH.D.,

Director of the School of Oriental Studies, and Professor of Persian, University of London.

LECTURE II. THE TURKS.

(Delivered April 29th, 1929.)

I should like to confess to you that when I undertook to lecture on the early Turks as a part of this course I did not realise, in spite of the amount of time I have devoted to this subject, how difficult a task I had set myself.

Scholars have dealt at enormous length with such details as the identification of the names of the tribes and the towns, and are for ever propounding new theories, but no one it seems has ever had either the time or the courage to piece together the puzzle In dealing with the Arabs, the Seljuks and the Mongols, one has a due series of historical records to go upon and positive dates and topography, but in dealing with these Turks, everything is more or less in the air When we consider how many big problems in regard to race origin still remain to be solved—such as the original home of the Aryans, of the Sumerians, or of the Georgians—it is interesting to find a nation which one can trace step by step from their original homes to the furthest limits of their migrations as we can trace the Turks from Mongolia to the Balkans, but our more precise knowledge of the Turks dates from comparatively recent times

Writing of the Tartars in 1820, the famous French Orientalist, Rémusat, remarks —

"The origin of these nations is still very obscure It is impossible as yet to say from how many races they sprang, and what territories they originally inhabited, or to determine with any certainty what circumstances led to their emigrations In the absence of data, due largely to the fact that no one has taken the trouble to collect and sift what does exist it is not surprising that the most contradictory theories should have been advanced regarding the antiquities of Tartary"

You must remember Remusat had access to the Chinese authorities which are plentiful, as the history of each dynasty had a special chapter on their foreign neighbours, quite apart from the incidental dealings they had with them During the last thirty years, however, Chinese studies have undergone a profound transformation, and the discoveries of archaeologists in Central Asia have set at rest some of the most vexed questions regarding the early inhabitants of Tartary Among these discoveries nothing is more arresting than the decipherment of the Turkish inscriptions of Northern Mongolia, which, taken together with the material found in the Chinese annals, give us a vivid picture of the Turkish race in the sixth, seventh and eighth centuries after they had left their settlements on the Orkhon and Selinga Rivers

The westward movement of the Turks from the steppes of Northern Mongolia constitutes the first stage in history of the penetration by various branches of this family into Central and Near Asia and into Europe, including the Pechinegs, the Comans, the Tartars of the Volga and of the Crimea, whose history forms an interesting subject of study and one that has received little attention except on the part of Turkologists

In my present lecture I wish not only to give you some idea of the origin of the Turkish people, but also to trace the beginning of their westward movements down to the period, namely, the middle of the seventh century,

when the Arabs, arriving from the opposite direction, had reached the Oxus country, and found themselves for the first time face to face with a Turkish power. It was not till the middle of the eleventh century that the Turks began to spread in large numbers over middle Asia (and this will form the subject of my next lecture), and it was the Arabs who barred the way to further westward progress during the intervening period, just as it was the Turks and the Chinese who prevented the Arabs spreading into Eastern Turkestan. For the rise and progress of the Turks down to the eighth century we rely upon Chinese historians, and for their subsequent history it is mainly to the annals of the Muslims that we must turn.

Central Asia, which was known to our forefathers by the convenient name of High Tartary, is surrounded on all sides by almost impassable mountains. There are only two natural exits, the one to the north-west in Zungaria, the other in the south-east. It was this latter exit that the earliest nomad and pastoral people of this inhospitable country usually selected as giving them, in a few days' march, easy access to the rich and fertile plains of China. This circumstance explains how it was that the great migration of Central Asian hordes did not take place until a comparatively recent date in the history of mankind, that is to say, in the third century B.C., when the Chinese, under an Emperor of the Ch'in dynasty, tiring of the incessant incursions of the tribesmen on their northern frontiers, of which their early records are full, set about the completion of the Great Wall by joining into one continuous wall the various barriers which had been from time to time set up by the barons of the northern marches. It was the construction of this formidable obstacle by the Chinese that led to the great Western migrations from Mongolia and Eastern Turkestan, and hastened the downfall of the Abbasid Caliphate.

With regard to the country in which we first hear of these nomadic races, I feel I cannot do better than read you a few extracts from a paper read recently before the Royal Geographical Society by Mr. Lattimore.[1]

"It has been roughly estimated that about a fourth of Mongolia is either utter desert, or so arid as to invite the occupation of only the poorest nomads. Not all of the remaining three-fourths are arid enough to compel nomadic pastoral life, without the alternative of settled occupation. Every important mountain range appears to be a centre of good climatic conditions, including a regular water supply, from which the climatic lines radiate outward and downward, through arable land and steppe country to sterile desert. This, however, is a physical structure which makes the mountains centres on which nomadic life converges, rather than barriers separating one climatic region from another. The tendency to a nomadic life, therefore, has always dominated the tendency of society to attach itself to particular localities and develop the culture of fixed communities. Well-favoured regions exist in Mongolia where agriculture

1 See *The Geographical Journal*, December, 1928.

is quite possible. Still more favoured regions are to be found, with abundant forests, good arable land, and easily worked mineral deposits, where it might be expected that men would readily turn from the nomadic life to one of permanent occupation. Historically, however, it has always been difficult for a minority to settle in such regions, because they lie open to regions in which a conversion from the nomadic to the agricultural life is not likely, and the accumulated wealth of settled inhabitants would provoke raids from the wandering tribes.

"It is evident that there have been attempts in Mongolia to break away from the nomadic tradition. In the fertile part of northern Mongolia, where numerous lakes and rivers drain toward Siberia, many tumuli and stone monuments indicate that the country was once held by the Uighurs, who appear to have been the central stock of all the Turkish tribes, and the first of the Turks to adapt themselves to agriculture and permanent habitations. The Uighurs, apparently, first showed a tendency to settle down while in this region, but they were dislodged by the tribes whose modern representatives are the Qazaqs, and after migrations which took them first westward, in the direction of Chuguchak or perhaps farther, they pitched at last on the northern flanks of the Tien Shan, which form the southern rim of Zungaria. There they speedily adopted agriculture and rose to a high degree of culture. Their capital is supposed to have been near the modern Urumchi, and they even spread beyond the Tien Shan to Turfan, which is in the true zone of oasis-culture.

"The first migration from Mongolia of "tidal proportions, that of the Hun tribes, appears to have taken place about the dawn of our own era, at a period when the power of the Chinese was also in the ascendant, and the Great Wall frontier was being asserted. The power of resistance which it represented gave the migration a set that took it to the north-west, away from China and the settled country and into the Russian steppes. There is ample evidence in history to show that this initial westward drift, though confirmed by subsequent migrations, was concurrent with periodic backwashes that affected China and northern Chinese Turkistan. Strong Hun tribes were established for a long time in the Barkol Tagh, dominating the obvious trade-route approach from Kansu province to Qomul (Hami) Turfan and Urumchi, and forcing the Chinese to work out the more difficult "silk road," the classical route through the wastes of Lop Nor into southern Chinese Turkestan."

The centre of interest for us lies, in the first place, between Lake Baikal and the Northern frontiers of China. The position of Lake Baikal is easily pictured if we remember that the Trans-Siberian Railway on its way from Vladivostok to Moscow skirts its Southern shores. It is from the country watered by the rivers which run into Lake Baikal from South to North that the ancestors of the Huns, the Turks and the Mongols migrated, and it is in this country that they established their capitals : notably the towns of Karakorum and Kara Balgassun. It includes Mongolia and the Great Desert of Gobi. It is bordered

on the North by Siberia, on the East by Manchuria, on the South by the Chinese provinces of Shen-si and Shan-si and on the West by Zungaria and the Altai and Chinese Turkestan and the Tien-Shan.

The only practicable land routes between Northern China and the West in ancient times were,

1. The route through Chinese Turkestan, which did not touch Mongolia at all and lay South of the Tien-Shan, and

2. The route through Central Northern and Western Mongolia and thence North of the Tien-Shan.

These were the alternative routes used for the silk trade

The term Chinese Turkestan is of course merely descriptive, for at the time of the first appearance of the Turks this country was inhabited by Indo-Germanian peoples, including the Iranian Sakas who lived between Kashghar and Khotan and the Ephthalites, who were established in the 5th century in Soghdiana whence they had driven out the Yüeh-chi or Kushans

The whole country which the Turks began to occupy in the sixth century, which we now call Eastern Turkestan was inhabited by people of Indo-Germanic stock, mostly Iranian South of Lob-nor there were Indians, North of Lob nor, probably as far East as Hami, were Iranian Soghdians whose influence stretched as far West as the Oxus, between Kucha and Turfan there dwelt a strange people called the Tokharians, whose Indo-Germanic dialect seems to belong to the European group, they were probably the descendants of the Yüeh-chi who, having driven the Sakas out of the valley of Ili, founded in the fifth century a powerful kingdom Both the Sakas and the Yüeh-chi had adopted Buddhism, as did later on many of the Turkish tribes

According to the Chinese, these nomads were divided from the earliest times into two main groups, namely, the Hsiung-nu and the Tung-hu. The Hsiung-nu were the ancestors of the Mongols and the Turks, and the Tung-hu of the Tunguz races, the ancestors of the Manchus and the Coreans. The oldest Chinese traditions tell us that, before the time of Yao and Shun, that is about 2500 B.C., while the ancestors of the Chinese were establishing themselves in Shensi and Shansi, they were brought into frequent contact with the wild nomadic people of the North and West. Their general name for these neighbours was Jung or Shan Jung; this name occurs both in the *Shih Ching* and in the *Shu Ching*. They also spoke of them as Hin Yung and Hun Yok. These names gave way later to the familiar name Hsiung-nu, which was current down to the sixth century A.D. All the names seem to point to an original name like Hsiun or Hun, which we find again in the Sanskrit Huna, and our word Hun.

But, though these two races, the Tung-hu and the Hsiung-nu, were sharply distinguished from the Chinese at the time referred to, there can be no doubt that at an earlier stage all three had to a great extent intermingled. The very circumstance of the constant raids in which the women as well as the flocks were carried off by the various peoples in turn, would imply much mixture

of blood; and the marriage of a chief to the daughter of a rival chief is often recorded in Chinese history. Moreover, different as are the old Turkish, the Tunguz and Mongolian languages, their resemblances and their mutual borrowing of words point to a close and constant intercourse between these peoples

It is probable that when the Hsuing-nu first came into contact with the Chinese they were no longer a purely Turkish people, so that, if we are to admit that the Huns who invaded Europe in the fourth century A.D. are to be identified with the Hsiung-nu it can hardly be claimed that they represent only one particular race. Their original habitat at the date of this contact must have extended far South into China. It was in the Southern portion of the present provinces of Shansi and Shensi that the first conflicts of the Chinese with the Hsuing-nu took place It is probable that the Chinese were in most cases the aggressors In the course of later history the Hsuing-nu were continually driven more and more to the north of the Gobi desert In A.D 220 the Hsuing-nu were conquered by Tunguzian Hsien-pi, who remained masters of High Tartary for about a hundred years Owing to the rise of other powers in Turkestan, the Hsuing nu power was finally brought so low that for several centuries they seem to disappear as a separate people They are not heard of again until one branch of them appears in the sixth century as Tu-chueh in the Koko-nor region.

The earliest monuments hitherto discovered of the Old Turkish language are the inscriptions found by Yadrintsef on the Yenissei River in 1890 These inscriptions belong to the Kirghiz and not to the Turks proper, though they are written in a language and a runic script closely resembling those employed in the famous monoliths discovered later on the Orkhon River. The Orkhon inscriptions, thanks to the researches of Thomsen of Copenhagen and Radloff of Petrograd, have brought to life again the earliest Turks known to us in history; for they give us a first-hand account of these people written by themselves These inscriptions are engraved on two monoliths situated about a mile apart in the desert country near Lake Kosho-Tsaidam to the west of the Orkhon River. They are about fifty miles north of the old site of the town of Karakorum, which was the capital of the Northern Turks, and twenty miles to the north-west of Kara-Balgassun, the ancient capital of the Uighurs, where Turkish inscriptions have also been found

The first of these monoliths bears on one side a long Turkish inscription engraved in honour of a certain Kutlugh Khan by his brother Bilgä Khan, and on the other some beautifully executed Chinese inscriptions bearing the date A.D. 732, the 20th of K'ai-Yüan of the T'ang dynasty The second monolith, which bears the date A.D 735, was erected in memory of Bilgä Khan who had died in the previous year. It likewise bears a Chinese inscription; and we learn that, on the occasion of the death of both these princes, the ruling T'ang Emperor sent special missions of condolence to the Turks and ordered inscriptions to be erected in their honour.

The contents of these great inscriptions fall into three distinct parts :—

1. General, containing a sketch of the history of the Turkish empire from its foundation down to the reign of Bilgä Khan.

2. A special detailed account of the doings of Kültaghin and Bilga Khan from the beginning of their reigns till their deaths.

3. An epilogue describing the services rendered by Bilga Khan and his people.

The history contained in the general portion deals with the foundation of the old Turkish kingdom in the middle of the sixth century down to its overthrow by the Chinese in 630 A.D. It next deals with the 50 years during which the Turks were struggling to release themselves from the Chinese yoke. Then comes the short description of the restoration of the Turkish kingdom under Kutlugh Khan, the father of Bilgä Khan, and the history of Mé-chue, the uncle of Bilga Khan, whose career begins at this time. They conducted battles against the Turgesh in the west, and against the Kirgiz whose Khan, Bars-beg, was killed, and to whom a *balbal** monument was set up. Finally we have the reigns of Bilga Khan and Kultaghin with their wars against the Oghuz and the Chinese.

It may interest you to hear how these early Turks are described in the contemporary Chinese annals.

"The T'u-Chueh wear their hair long and loose, throw the skirt of their garment to the left side, and live in felt tents. They wander from one place to another, settling down where they find water and grass. Their chief occupations are tending their flocks and hunting. They have little respect for old age, but show great admiration for a man in the prime of life. They are without any sense of honour and have no idea of law and justice, in which they resemble the Hsuing-nu.

Their functionaries are divided into 28 distinct classes, and all the offices are hereditary.

Their arms are bows and arrows, lances, sabres, swords and breast plates. They are skilled horsemen and archers. They wear belts ornamented with carved and embossed designs. Their flag staffs are surmounted with the head of a she-wolf in gold. The king's gentlemen in waiting are called *fou-li* (*i.e.*, *Buri*, a word meaning wolf).

When a man dies, his body is placed in his tent. Then his sons and nephews and relations of both sexes each kill a sheep and a horse, and spread them out in front of the tent as though offering sacrifice. They ride round the tent seven times uttering melancholy wails, and as they pass the door of the tent each one cuts his face with a knife, so that his blood mingles with his tears. When they have been round seven times they stop. Then they choose an auspicious day and burn the horse belonging to the deceased together with all his possessions. The ashes are gathered up, and the burial must take place

*A *balbal* is, it seems, a monument set up in commemoration of a defeated enemy.

at certain fixed times If a man dies in spring or summer, he must not be buried until autumn has come and the leaves have fallen from the trees. If he dies in autumn or winter the burial must be postponed until spring when the trees and plants are in leaf. Then a grave is dug and the corpse buried, and on the day of the burial the relations offer sacrifices riding round on their horses and cutting their faces as on the day of death. After the burial, stones are placed over the tomb and a sort of monument erected, on which is painted a representation of the deceased and of the combats in which he has been engaged The stones vary in number according to the number of his enemies the deceased has killed If he has only killed one, one stone is placed on the grave; some, however, have as many as a hundred and a thousand

After the death of a father, an elder brother or an uncle, the sons, the younger brother or the nephews marry their widows and sisters Although the T'u-Chüeh wander from place to place, each one possesses a certain portion of land. The Khan lives permanently on the mountain of Tu-Chin His tent faces east out of respect for the quarter in which the sun rises. They pay homage to demons and spirits and believe in magic They glory in falling in battle, and would blush to die of illness "

The T'u-chüeh flourished from the middle of the sixth century to the middle of the eighth The first allusion to the T'u-chüeh in the Chinese annals occurs in the year 545, when the western Wei Emperor sent an embassy to them, and in this connection we are told that originally they formed a small kingdom to the South-West of the Altai mountains These T'u-Chueh had migrated from the North, and in the middle of the fifth century had settled in the neighbourhood of Lake Kokonor, and were tributary to the Tunguzian Juan-Jüan (Avares) under whom they lived in a state of subjection as workers in iron. Under their Khan, Tümen, they had, by the middle of the sixth century, attained to considerable power, and had begun to infest the western frontiers of the Wei emperor; and it was for this reason that the embassy was sent to them from the Chinese Court

In 551 Tümen married a daughter of the Emperor T'ai-tsu, with whose aid the T'u-Chüeh defeated their former masters the Jüan-Jüan. Tümen thereupon adopted the Jüan-Jüan title of Ili-Khan. This is the earliest mention of the title Khan or Khaghan. His younger brother, Istämi Khan, who accompanied Tümen on all his expeditions, was the head of the section of hordes known as the Turks of the Ten Tribes; and it is from him that the Western T'u-chüeh traced their descent. Both these chiefs are mentioned in the Orkhon inscriptions. Tümen died in 552 and was eventually succeeded by his son Mokan, who in 554 finally routed the Jüan-Jüan, and the Turks thus became masters of all the country from Korea right up to the Caspian.

They now came into collision with the Ephthalites, or White Huns, with whom the Jüan-Jüan had concluded a treaty of peace, and who had been established since 450 in the rich country between the Yaxartes and the Oxus,

whence they had driven out the Yüeh-chi (Kushans or Indo-Scythians). The Ephthalites had been engaged in continual warfare with the Sassanian rulers of Persia. In 555 the Sassanian monarch requested and obtained from the Turkish Khan a Turkish princess in marriage, and a year later he sent a letter to Mokan Khan asking him for aid against the Ephthalites. To this the Turkish Khan agreed, and the Ephthalites, caught between two powerful enemies, were finally defeated. The Turkish Khan, having established himself in Transoxiana, wrote a letter to the Persian King, Anushirwan, saying that the blood of their common enemies had reddened the waters of the Oxus.

As a result the Ephthalite empire was divided between the Khan of the Turks and Anushirwan of Persia. Roughly speaking, the Oxus formed the dividing line.

The Turkish language had not apparently come into its own at this date, for this letter, we are told, was written on satin and in Chinese. The Persian King had this letter translated by a priest in his employ and sent a reply written on paper in the Pehlevi or old Persian language.

The power of the Sassanian dynasty was already waning; and the Turks, elated with their recent triumphs, were not slow to take advantage of the good bargain they had struck. Within a short time they had practically annexed all the countries which had been included in the later Kushan Empire, for no sooner had the Turks become their neighbours than they showed themselves to be the worst enemies of the Sassanians. They did all they could to encourage the Byzantines to attack the Persians. In A.D. 568 the first Turkish embassy was sent to the Byzantine Emperor, and in the following year a mission arrived at the camp of the Khan (called by the Greeks *Dilzibul*, in part a corruption of the Turkish title *Yabghu*) from the Emperor Justin II. The object of this mission was to secure a direct route to Europe of the raw silk, and thus to avoid the obstacles put in the way by the Persians, who had, owing to their geographical position, created a monopoly of the Chinese silk trade. Although Justinian had managed to secure through certain missionaries a number of silk-worm eggs and had thus established the manufacture of silk in the Greek empire (552), the large and increasing demand for raw silk could not be in this way satisfied and the importation through Persia involving heavy duty still continued. It was during the reign of Justinian that the Turks reached the height of their power; and with their capital near the modern Urumtsi, in the neighbourhood of Lake Balkash they controlled practically the whole country from Eastern Turkestan to the Chinese frontier; and thus all Chinese merchandise was obliged to pass through their territory. There were three routes, all of which began by the crossing of the Gobi desert to Hami:—The main route lay through Soghdiana, that is, the country round Samarkand; but when the Turks became master of this country the Persians became anxious lest the Turkish armies might follow in the steps of the silk caravans, and they therefore forbade the Persians to buy silk from the Soghdians. It was at

the request of these local merchants that the Turkish Governor sent an embassy to Persia to request the withdrawal of this ban. We are told that the Persian king not only refused this request, but actually burnt in the presence of the envoys the silk they had brought with them

The Soghdians were therefore compelled to find some other outlet for their silks, and it was at their suggestion that the Khan of the Turks entered into friendly relations with the Byzantines The Emperor Justin II received them in the most friendly way and sent a return embassy to confirm his treaty with the Turks (568-569). Thereafter the caravans were directed to the north, but the exact route is not known

The trade through Transoxania was only resumed after the fall of the T'u-chüeh in the first half of the 7th century

In 630 the Northern T'u-chüeh who had split off from the Western Turks were totally defeated by the Chinese and there followed a period of fifty years of slavery, which is referred to in pathetic terms in the Orkhon inscriptions In 659 the Chinese subdued all the country of the Turks, but in 681 a new Khan arose named Kutlugh, who temporarily revived the prestige of his people by uniting them He proclaimed himself Khan of all the Turks, and after defeating the Chinese, invaded the country of the Western Turks

The Western Turks finally appealed to the Chinese to be allowed to occupy one of their provinces On the death of Kutlugh, about 691, his younger brother Mé-chüeh became Khan of the Turks, who nevertheless still remained nominally vassals of the Chinese Throughout his reign he continued to give trouble to the Chinese, but we are told that owing to the rapidity of the movements of the Turkish hordes, who would appear suddenly on marauding expeditions and disappear again before the Chinese troops could arrive on the scene, pitched battles were seldom fought

On the death of Mé-chüeh in 716, Kultaghin, the son of Kutlugh, assumed command of the Turkish hordes and, having put to death the sons and brothers of Mé-chüeh, placed on the throne his eldest brother under the title of Bilga Khan. In 731 Kultaghin died, and on his death the Chinese Emperor sent a mission under the Imperial seal to carry condolences to the great Khan and to make offerings on his tomb. The Emperor ordered an inscription to be engraved and a statue of the dead Khan to be erected, and a temple to be built, on the walls of which battle pictures were to be painted Bilga Khan in return asked for a Chinese princess in marriage To this the Emperor agreed, but the Khan died by poisoning before the arrival of the princess. This was in 734 The Emperor again sent condolences and ritual offerings to the Turks and ordered a further inscription to be erected Such is the origin of the two monoliths of the Orkhon

Bilgä Khan was succeeded by his son, who died after a reign of eight years. His death was followed by great disturbances throughout the country of the Turks, and in 745 the chief of the Uighurs became possessed of all the country of the Turks and put to death their last Khan.

After this date the Turks are seldom mentioned in the history of China. The last mention occurs in connection with an embassy sent to the Emperor of China in 941. Without doubt, after their conquest by the Uighurs, these Western Turks began to lose their identity, and were gradually absorbed into other branches of the same race.

The Uighurs first appear in history in the sixth century, when they were known as the Kao-ch'e or "High Carts," being one of the two main divisions of the Turks in and around Northern Mongolia. They re-appear in the seventh century under a new name Hui-ho, which is probably the Chinese rendering of the Turkish Uighur. In 742 they conquered Mongolia from the Northern Turks. Their period of greatness was about 750-850, corresponding with the zenith of the famous T'ang dynasty. They had their capital at Kara Balgassun in the Orkhon country. Among their most important towns were Bishbalik, Kara Khoja and Turfan. They were finally defeated by the Kirghiz. They attained a very high level of culture, and recent archæological research has brought to light a vast amount of Uighur literature and art. From this we learn that Christianity, Buddhism and Manichaeism were all practised in their kingdom, the utmost tolerance being observed; but Manichaeism was the state religion. The Uighurs were certainly the most civilised of all the northern neighbours of China; and, though their kingdom was destroyed in 850 by a Northern Turkish Tribe, the Kirghiz, they by no means disappear from history. Down to the fifteenth century we constantly find small Uighur principalities and states springing up, while during the whole of this period the Uighurs were extensively employed in Muhammedan chancelleries, playing much the same role in the Government Offices of Turkestan as the Panjabi Hindus under the Delhi Moghuls and the Bengalis under the British in India.

The Uighur language bears the closest resemblance to the Turkish of the Orkhon inscriptions, and continued to be employed as a literary medium at any rate down to the twelfth century. Prior to the conversion of the Uighurs to Islam, their language had been widely used for the translation of Buddhist, Christian and Manichaean works, which have only been brought to light in recent years. The T'u-chueh and the Uighurs are therefore the two great branches of the Turkish speaking family with whom all the Turks of to-day may claim relationship if only on linguistic grounds.

If the Iranian civilisation had the upper hand in Turkestan it did not hinder the Turks from cultural development. Buddhism was studied by the Turks with all seriousness, and apart from translations from the Chinese into Uighur of the best-known canonical works, we have commentaries on the Abhidharma which have the appearance of notes taken by a Turk while studying the Chinese originals.

Finally Turkish got the upper hand in the whole region, so that by the end of the tenth century the Indo-Germanic languages, Soghdian, Oriental Iranian and Tokharian had died out altogether.

Persian has, however, survived in old Soghdiana. For in Smarkand and Bokhara one still hears both Turki and Persian in the bazaar. This Persian, known as Tajiki, differs in many respects from the Persian of Iran proper, and in it we have words which are to be met with in the Shah Nama, but are no longer current in Persia As you are all aware, the Soviet has created a separate Republic for these Persian-speaking Turkestanis called Tajikistan.

A few words may be said in conclusion on the names Turk, Tatar and Moghul, which have given rise to much confusion With regard to the name Turk, there can be no doubt that it was the name by which the Turks were known to others and among themselves in Central Asia in the sixth, seventh and eighth centuries. In their inscriptions they speak of themselves by this name, while the Chinese T'u-Chüeh is obviously a corruption of the same word

In these inscriptions they call their language Turkcha.

As for the word Tatar, it is probably derived from the Chinese word Ta-ta or Ta-tse, which first appears in the Christian Era and corresponds more or less to the Greek term "barbaros" It was applied by the Chinese to the peoples on their northern frontiers The name Tatar is now only used by, and applied to, the Turks of the Volga and the Caucasus, the descendants of those Tatars who for several centuries ruled over part of Russia

The names Mongol and Moghul have of course a common origin, and the Mongolians have survived as a race since the days of Chinghiz Khan In the 15th century Russian Turkestan was known to Muslim writers as Moghul istan; and the famous Emperors of Delhi, the descendants of Tamerlane, were known as the Great Moghuls, though they were in reality not Moghuls but Turks. The Ghaznavid dynasty, which preceded them (c.900-1200 A D) in Northern India were, however, avowedly Turks, while the Slave dynasty which ruled over Northern India from 1206 to 1290 was founded by a Turkish slave named Kutbud-din. The reason why the Delhi Emperors called themselves Moghuls rather than Turks was probably not unconnected with their desire to claim descent from the great Chingiz Khan as well as from Tamerlane

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

TUESDAY, OCTOBER 1. Automobile Engineers, Institution of, at the Royal Automobile Club, Pall Mall, S.W. 8 p.m. Prof. W. Morgan, Presidential Address, "The Member and the Institution"

WEDNESDAY, OCTOBER 2. Analysts, Society of Public, at Burlington House, Piccadilly, W. 8 p.m. (1) Dr H. F. Cox, "Chemical Tests in Relation to Fur Dermatitis." (2) Mr J. H Coste, "Demonstration of a Nomogram for use in Gas Analysis" (3) Mr. P. S. Arup, "The Composition of Irish Winter Butter." (4) Messrs. W. R Schoeller and H W Webb, "Investigations into the Analytical Chemistry of Tantalum Niobium, and their Mineral Associates." XVI Observations on Tartaric Hydrolysis. XVII. The Quantitative Precipitation of the Earth Acids and certain other Oxides from Tartrate Solution

THURSDAY, OCTOBER 3. Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof Arthur Thomson, "Anatomy—The Erect Posture in Man and the Characteristic Features dependent thereon."

Engineers, Society of, at Burlington House, Piccadilly, W 6 p.m. Mr W. J Hadfield, "Some Road Questions."

FRIDAY, OCTOBER 4. Junior Institution of Engineers, 39, Victoria Street, S.W. 7.30 p.m Mr. C. I. Hill, "Engineering Experiences on a Tea Estate in Assam."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

NOMADIC MOVEMENTS IN ASIA

By Sir E. Denison Ross, C.I.E., Ph.D.,

Director of the School of Oriental Studies, and Professor of Persian, University of London.

Lecture III. The Seljuks.

(*Delivered May 6th, 1929.*)

In my previous lecture I attempted to describe the manner in which the Turks migrated or drifted westwards from their ancient habitats in Mongolia into the fertile basins of the Ili and Tarim rivers, and even into Soghdiana. I brought the story down to the beginning of the eighth century, when a final effort on the part of the Eastern Turks came near to bringing about the restoration of the United Turkish Empire, an effort which was frustrated by the diplomacy of the Chinese. Such was the position when the Arabs, after wasting upwards of fifty years in desultory raids into Transoxania, set about the serious invasion of that country under their famous general Kutayba.

Towards the end of the eighth century we find two Turkish kingdoms on the Jaxartes: on the upper reaches of this river were the Karluqs, and on the lower the Ghuzz or Oghuz, a section of the Western Turks. In and around Kashghar there was a third powerful Turkish kingdom belonging to the Kara-Khanids. [The main Uighur kingdom first established in the middle of this century was brought to an end, as we have seen, by the Kirghiz in the middle of the ninth century.]

As we are only concerned with the migrations of the Turks I must now pass at once to the last decade of the tenth century, which saw the first beginnings of that great infiltration of this race into the middle and near East.

In the interval the Abbasid Caliphs had become masters of all the country lying between Khorezmia on the North, Chinese Turkestan on the East and India on the South ; but already, at the beginning of the ninth century, the Caliph was losing his hold on the Eastern provinces of Islam ; and by the end of that century we find there the Samanids, a native Persian dynasty exercising independent rule, though outwardly acknowledging the authority of Baghdad, with their capital alternatively in Samarkand or in Bukhara The Samanids at the height of their power ruled over Khurasan, which then extended to the Oxus, and included Herat and Merv, Transoxania, the province of Ghazna extending from Balkh to the Panjab, and Khorezmia. Their most troublesome neighbours were the Turks on their Eastern frontiers During the whole of the tenth century there were frequent incursions or invasions made from either side. We also hear of hordes of Oghuz Turkomans being allowed by the Samanids to occupy land in Transoxania, land suited only to nomads, and engaging in return to protect the frontiers from all inroads, and it is in this connection that we first hear of Seljuk, the grandfather of the two brothers who founded the Seljuk Empire.

We read in Gibbon's Chapter 57 the following accurate description of the situation in Central Asia at this period : "In the decline of the Caliphs, and the weakness of their lieutenants, the barrier of the Jaxartes was often violated : in such invasion, after the retreat or victory of their countrymen, some wandering tribe, embracing the Mahometan faith, obtained a free encampment in the spacious plains and pleasant climate of Transoxania and Carizme. The Turkish slaves who aspired to the throne encouraged these emigrations, which recruited their armies, awed their subjects and rivals, and protected the frontier against the wilder natives of Turkestan."

In the year 985 a branch of Turkomans under the leadership of Seljuk, separated from their fellow-tribesmen in and around Jand, in the lower reaches of the Jaxartes, turned Muslim and were allowed by the Samanid ruler to settle in Nur, north-east of Bukhara.

The most redoubtable Turks on the Eastern frontier of Transoxania were at this time the Kara-Khanids, who are reported by legend to have embraced Islam in the middle of the tenth century. The Kara-Khanids, as near neighbours of the Uighurs, were probably more cultivated than the Turkoman Seljuks. In 992 Bukhara was entered by Bughra Khan, who shortly after withdrew, owing, it appears, to ill health. But a fresh invasion took place in 995, and the Samanid king (Nuh), whose forces had been considerably reduced by revolts within his kingdom, decided to appeal for assistance from Sebuktagin, a Turk who was governor of Ghazna, and had rendered great services to the Samanids. In 999 Sebuktagin died and was succeeded by his famous son

Mahmud of Ghazna, who in the course of his thirty years reign made himself master of all the territory possessed by the Samanids.

The Ghuzz Turks had by this time arrived in vast hordes in Transoxania, and already in the Samanid period many of them had settled round about Samarkand and Bukhara. The Ghuzz, like the Turkomans, belonged to the Western Turks, and on arrival in Muslim territory soon adopted the religion of the Arabian prophet and always became rigidly orthodox Sunnis, a circumstance which had a very far reaching influence on the history of Islam

Later on bodies of these Turks began to penetrate into Khurasan from both sides of the Oxus, only to be driven out again by the Ghaznavids, and scattered westwards as far as Hamadan and Mosul, robbing and pillaging as they went and making good government impossible for the lesser princes of Persia and Mesopotamia. Thus gradually the whole of Northern Persia was overrun by Turks, who formed a valuable nucleus of partisans for the more or less organised hordes which were soon to arrive in Persia under the leadership of the indomitable Seljuks. One naturally asks what particular quality it was which differentiated the Seljuks from the numerous other hordes which were continually passing into Khurasan and beyond

The sudden rise of the Seljuks may probably be due solely to the personal factor. Really capable men like Tughril and his brother Chaghri by sheer individual prestige attracted to their banners Turks of any horde that was in their neighbourhood just as Chingiz Khan, though actually a Mongol, attracted to his side countless Turks

That we know so little of the rest of the Ghuzz is no doubt due to the fact that if they found no great leader, the name of their tribe or tribes would be ignored by native historians, and having reached the end of their wanderings, they either became merged in the local population, or attached themselves to some new chieftain who might be moving further afield.

We next hear of the Seljuks under the two brothers Tughril Beg and Chaghri Beg, the grandsons of Seljuk, forming an alliance in 1034 with the Ghaznavid Governor of Khorezmia, who had revolted against his masters. In the following year, dissatisfied with the treatment they received from the "Khwarazm Shah," they decided to follow the example of the other Ghuzz and cross the Oxus into Khurasan, where they managed to make themselves masters of the important towns of Nasa, Merv and Nishapur. A battle at Dandanqan in 1040 finally put an end to Ghaznarid rule in Khurasan and in the words of Gibbon "founded in Persia the dynasty of the Shepherd Kings."

Mas'ud of Ghazna, who had been during this time mainly engaged with the affairs of India, now, too late, awoke to the gravity of the situation in the North, and made several attempts to drive the Seljuks out of Khurasan as did also his son Maudud, who succeeded him in A.D. 1042. The actual possession of this great province continued a question of dispute down to A.D. 1059, when, by a treaty, it was definitely ceded to the Seljuks together with Balkh, Herat and Sistan.

While Chaghri Beg was left to consolidate the power of the Seljuks in Khurasan, Tughril Beg was pursuing a career of conquest in the West; and parcelling out his newly-acquired territories among his numerous brothers and nephews. These early conquests included Iraq, Kirman, Azarbaijan, Hamadan and Gurgan. He selected Rayy as his first capital.

Persia was at this time split up into a number of independent principalities, which had nothing in common but a nominal recognition of the Caliph: and there could be no question of any combined effort on their part to show a united front to the advancing armies of Tughril. The once powerful Buwayhids who, since the middle of the tenth century had exercised complete control over the Caliphs of Baghdad, and had founded states in Southern Persia and Iraq, owing to family feuds had lost much of their former power and influence, and although they were able, by obstinate bravery, to delay Tughril's progress through Southern Persia—notably at Kirman in 1047 and at Ispahan in 1051, which only surrendered after being completely starved out—they were obliged in 1055 to recognise defeat.

In 1054 Tughril determined on a final coup, and after securing his flank by a successful raid into Azarbaijan, marched direct on Baghdad. Here the political situation was all in his favour. The Shi'a Buwayhids had placed the affairs of the orthodox Caliph under the control of a certain Basasiri, whose position had been much weakened by the hostility of the Beduin Chiefs of Iraq. Baghdad was moreover the scene of constant disputes between the Sunnis and Shi'as. The arrival of the orthodox Tughril in the neighbourhood of Baghdad must have inspired new hope in the heart of the Caliph Kāim, who was even suspected of having invited the redoubtable Turk to come and deliver him from his Shi'a guardians.

In December, 1055, Tughril entered Baghdad in state and was loaded with favours by the Caliph, who seated him on a throne and clothed him with a robe of honour. The conversation they now held was interpreted by Tughril's famous vezir Kunduri. Tughril probably only spoke Turkish, for none of the Seljuks were educated men, and we have it on good authority that even Sanjar, the last of the great Seljuks, was illiterate. They left learning and the encouragement of learning to their Persian ministers. We may recall that the great Emperor Akbar of Delhi is said to have been illiterate, but no one could accuse him of lack of culture.

Meanwhile, at the approach of Tughril, Basasiri had fled, and although no opposition was raised against the Seljuk's entry into Baghdad, the presence of his nomad hordes was by no means welcome to the inhabitants, and in order to avoid possible disturbances, and thus preserve the political advantages he had gained, Tughril shortly afterwards left Baghdad, but not before giving his niece, the daughter of Chaghri Beg, in marriage to the Caliph, and thus cementing the good understanding arrived at between the first Arab in the land and the self-made Turk. During the twelve months which followed Tughril and his generals succeeded in subduing Mosul and Diyar Bekr.

Meanwhile, Basasiri was planning revenge. He gathered round him many of the Beduin chiefs of Iraq, intrigued with the Fātimids of Cairo and even stirred up dissension among the Seljuks themselves, by inducing Ibrahim ibn Inal, a cousin of Tughril's, who had been made governor of Hamadan, to revolt. It must here be noted that the Turks always retained the idea of the family, and though they recognised the head of the clan, they did not aim at sole and individual rule by one chief, but bestowed newly conquered territories on their immediate kinsmen, giving them almost independent powers. This same characteristic is equally notable in the case of the Mongols at a later period, when Chingiz divided his vast Empire among his sons. This was a very different policy to that pursued by other oriental dynasties, whose kings on accession to the throne were in the habit of putting to death, or at best blinding, all potential rivals, especially their brothers The subsequent history of the great Seljuks goes to show how dangerous this policy might become when the Nomads began to settle in a strange land. The revolt of Ibrahim ibn Inal was a case in point, and the situation was only saved by the prompt action of Tughril, who sent three of his nephews to punish the rebel, and having captured him, caused him to be strangled with the string of his own bow.

Tughril next turned his attention to Basasiri and his Beduin chiefs who had, in the interval, re-occupied the Residency in Baghdad, and in a fierce engagement which ensued, Basasiri, deserted by his new allies, fell into Tughril's hands and was beheaded This was in 1059, and after this success the founder of the Seljuk state refrained from all further aggression and set about the consolidation of his Empire

Chaghri Beg had just died, and his son, Alp Arslam, was given the Governorship of the Eastern provinces. Chaghri's widow, who was his second wife and the mother of his son Sulayman, was now married to Tughril.

Although Tughril seems to have grown weary of campaigning, his ambitions were not altogether satisfied, and in spite of his old age he had made up his mind to ally himself yet more closely with the Caliph, and sent his vezir Kunduri to ask for the hand of the Caliph's daughter But in spite of the deep obligations of the Caliph towards the man who had released him from the Shi'a tutelage, and in spite of the fact that Tughril could at any moment dethrone him, his aristocratic Arab blood revolted against such an alliance with this crude Turkish chieftain, who was devoid of all the elegancies and nearly seventy years of age, and he at first refused. Some writers have also suggested that the initial refusal was prompted by a determination to make the price as high as possible, and indeed one of the conditions proposed was the immediate restoration of the Caliph's sovereignty over Baghdad.

Not before the end of 1062 was Kunduri able to report a successful termination to these long drawn out negotiations, and at the beginning of the following year preparations were made for the marriage, which was to take place at Tughril's capital, Rayy The princess on reaching Tabriz learnt, (we may

imagine to her great relief) that the bridegroom had died after a few days of illness. Thus was the great Tughril, on whom fortune had been so constant an attendant, cheated of his last great ambition.

In less than twenty-five years, from their first successes in Khurasan in 1037 down to the death of Tughril in 1063, these two brothers had conquered the whole of Persia proper, and what is perhaps equally remarkable, had introduced orderly government into a country which for nearly two hundred years had been the scene of discord and civil war. But it was not only Persia that was resuscitated by the conquering Seljuks; Islam itself seemed on the eve of disruption: neither the Sunni nor the Shi'a Caliphs were able to give it anything approaching its earlier homogeneity, there was no really paramount power in Asia. It was Tughril who revived the waning prestige of Islam; who postponed for nearly two hundred years the extermination of the Baghdad Caliphate, and it was his conquests which paved the way for the foundation of the last great Muslim Empire, that of the Ottomans of Turkey The failure of the Crusaders to make a lasting impression on Asia may also be in a large measure accounted for by the existence of this strong Central Empire.

It is one thing to conquer, and another thing to hold, and we must not forget that the Turks, though great soldiers, were very seldom administrators; but, like the early Caliphs of Baghdad, they turned to the Persians: and if the Seljuks were fortunate in their leaders, they were equally fortunate in the great Persian ministers they attached to their service; without whom it is unlikely that they would have been so clearly distinguished from the many hordes of Turks who plundered their way across Asia.

It was, however, a great misfortune for the oriental world that the race which contributed most to the strength and continuance of Islam should have been illiterate and uncultured barbarians. This epithet does not, of course, apply to all the Turks; for long before the time of Mahmud of Ghazna—who at any rate attracted to his court the first men of letters of his day—there were branches of the Turks, notably the Uighurs, who had taken to a settled life and had developed a literature of their own. The nomad Turk, however, had no predilection for letters or art, and in spite of the generous patronage, which men like the vezir Nizam ul-Mulk gave to literature and science, the triumph of the Turk over the Arab gave a permanent set-back to that appreciation of Western thought and science which the Arabs had displayed immediately after their emergence from the desert. For the Arabs who brought nothing with them but their rich language and its fine poetry, at once showed an eagerness to benefit by their intercourse with both Byzantium and Persia, and from the treasure house of Greek Science laid the foundations of a vast literature comprising philosophy, mathematics and the natural sciences, which though it owed its origin to Greek or Syrian originals, soon took on a character of its own and gave rise to various native schools of thought.

The Turks, who brought nothing with them, cared for none of these things,

and it was only thanks to their cultured Persian advisors that Arabic learning and Persian literature survived. It is true the Seljuks did not, as did the Mongols two hundred years later, set out to destroy the monuments of Muslim literature, and this must be reckoned to their credit; for the Mongols, like the Seljuks, had in their service men like Rashid ud Din and Juwaini the historians, who were the intellectual equals of Kunduri and Nizam ul-Mulk, but were powerless to stay the wholesale destruction of the libraries of Baghdad wrought by Hulagu.

It should also be borne in mind that although the mass of these hordes were quite rough, their leaders often showed themselves susceptible to refined influences. A famous Muslim Geographer of the middle ages, speaking of the Turks, observes: "Their princes are warlike, provident, firm and just: they are distinguished by admirable qualities: the nation is cruel, wild, coarse and ignorant."

From the point of view of the peaceful merchant or cultivator it is difficult for us to judge whether they were able to notice any difference between the raids of the Ghuzz and the invasion of the Seljuks; both were probably more alarming than the constant wars between the Ghaznavids and the local Persian princes. In these last it was mainly the regular soldiers which were engaged, under trained generals, whereas the Ghuzz, who were solely bent on loot and pillage, were allowed to practice without restraint every kind of depredation. The military adventures of the princes and their generals often make good reading, and their prowess fills us with admiration—but one is apt to feel the aimlessness of it all and to be disgusted by the wanton waste of human life, and to regret the absence of all cultural interest outside the field of religious fanaticism: a thick mist of battle, murder and rebellion seems to cast its shroud over every page of Islamic history and leaves one with the impression that the average inhabitant of Persia and Central Asia spent his days in either apprehension or terror. And yet we know that in spite of these constant wars and rebellions the system of administration under the Samanids and the Seljuks was elaborate and sound in theory, and that on the whole justice was well administered. Moreover, in the midst of all this rivalry of warring chiefs and the burnings and pillagings of towns, the student in his cell, the astronomer in his tower, the poet at the court and the preacher in the mosque, still existed; but as they are for the most part ignored by the chronicler of the day we must discover their existence by piecing together the broken mosaics which may be found after careful search in the rare books of travel, and in those rare passages in Persian poetry which contain personal allusions or references to passing events.

Thanks to the preservation of Nizam ul-Mulk's "Book of Government," we have very precise information regarding his, Nazim ul-Mulk's, system of administration. As has already been mentioned, in the eyes of the Turkish nomads the Empire was the property of the whole family of the Khan; and not only were entire provinces given over to uncles, brothers and sons, who

ruled them in their own name, but there was further introduced a system of territorial fiefs (*iqtá's*) which were distributed to distinguished soldiers in lieu of payment of grants or in part payment. Nizam ul-Mulk himself tells us that this was an innovation and that in the Ghaznavid Empire troops were paid in money only. Fief holders were only entitled to demand a specific sum from the inhabitants and had no rights over the persons' property, wives or children of the population.

The great vezir also describes the difficulties that were encountered in training nomad chiefs to adopt a sedentary life and to submit to the same administration as the settled population. Under former Persian rulers there had been a strong force of "guards" composed of bought slaves and mercenaries, and some means had now to be found whereby the nomad invaders might be brought under the same system. In his "Book of Government" he gives a most interesting account of the measures he adopted for training large numbers of young Turkomans to become servants of the court, without interfering with the interests of the settled population. He was also strongly opposed to the holding of more than one post by any individual, as this tended to increase the number of unemployed in the official class, who were always an element of unrest.

Sanjar, having spent twenty years as virtual ruler of Khurasan, was destined to spend forty years as master of the whole Empire. His reign was distinguished by great successes and great reverses. Among the former were his conquests of Ghazna, Samarkand and Sistan. Among the latter was his defeat at the hands of the Kara-Khitais, which deserves special notice on account of its curious repercussion in Europe. Mahmud Khan, the Kara-Khanid King of Transoxania, had invoked Sanjar's help against the Karluk Turks who had invaded his country. The Karluks in their turn appealed for aid to the Gur-Khan (or Universal-Lord) of another group of Turks known as the Kara-Khitaïs. Negotiations for a peaceful settlement having broken down, mainly owing to the haughty attitude adopted by Sanjar, a sanguinary battle was fought in the Katwan steppe in September, 1141, in which the Seljuk army was totally defeated and fled, leaving half the army dead or wounded. The Kara-Khitaïs in the same year occupied Bukhara.

The reports of this defeat, which reached Europe shortly after, led to the belief that the Seljuks had been defeated by a Christian prince on their Eastern frontier; and hopes were cherished that a new Christian ally had suddenly appeared who would simplify the Crusaders' task of attacking the Seljuks in the rear. It was actually this rumour which led to the belief in the Christian kingdom of Prester John in Central Asia; and there was this much of justification for the report, in that among the Turkish tribes fighting for the Gur-Khan some professed the Christian faith.

The main cause of anxiety to Sultan Sanjar during most of his reign was Atsiz, the Khwarazm Shah who succeeded to the Governorship of Khorezmia

in A.D. 1128. Although when he died he was still the vassal of the Seljuk Sultan, he must be regarded as the real founder of the dynasty of independent Khwarazm Shahs, who in the thirteenth century were the last bulwark between Persia and the invading Mongols. The story of the constant revolts of Atsiz and the repeated expeditions into Khorezmia of Sanjar make wearisome reading, and need only be referred to because they certainly hastened the break-up of the Seljuk Empire.

It was however his near kinsmen the Ghuzz nomads in Khurasan who finally brought Sanjar's rule to an end. In A.D. 1153 the leaders of these Ghuzz, enraged at the Sultan's attempt to subdue them to the rule of Persian officials and tax-collectors, rose in revolt, and not only destroyed his army but took the Sultan himself prisoner. He remained in their hands until 1156, when some of his faithful retainers managed to obtain his release by bribing his custodians. He was brought safely to Merv and began to collect a new army, but grief at the ruin and desolation of his country, combined with old age—he was then seventy-two—caused his death a few months later. In these tragic circumstances did the Empire of the great Seljuks come to an end in A.D. 1157.

EXHIBITIONS OF APPLIED ART.

MODERN TENDENCIES IN DECORATION. Messrs Heal's, Tottenham Court Road. Exhibition open till Oct. 31st.

Mr. Ambrose Heal is a modern rather in the way that Mr. Bernard Shaw is a modern. He is direct and earnest, and never more conservative than when he is being emancipated. Much of Mr. Heal's work, so excellent of its kind, seems to say: It's all right, my dear man and woman in the street: you may come near me, you may even acquire me, and I shall do you no harm. I am really as innocent as aspidistras.

And so it is. Far, far better than aspidistras, too, and better than much that is truly antique or truly modern. Mr. Heal's work is not what we mean by modern. It insists on the intrinsic attractions of grain. But did not the eighteenth century do the same? The eighteenth century insisted on something else at the same time: the twentieth century tends to expect materials and techniques to shoulder responsibilities that are beyond them.

Now in order to bring out the character of a material, the artist or craftsman has got to do more than, so to speak, make smooth its path by choosing "artless" forms. Nothing is more "arty" than artlessness, unfortunately. When art is not primitive it must have urbanity; there is no possible compromise.

To come to the present show at the Mansard Gallery. The furniture is in three kinds of wood: macassar ebony, walnut and oak. The first named is luxurious. The clear cut design of the suite in which it has been applied brings out the rather unsympathetic hardness of the wood, which is here inlaid with ivory. Altogether pleasanter is the French walnut suite, though the straight grain attracts too much attention to itself. It is advisable *celare artem* more than this. Some of the designs in oak are still more agreeable. They are always educative: they state the problem well even when they do not solve it.

The general level of the textiles shown is a high one, and some of the patterns are very good. Artificial silk is here and there seen mixed with other materials, with a pleasant enough effect: less sheen is imparted than one might expect.

Some of the glass for table use is elegant. If one can be satisfied with something less than Corbusier and Lalique, a visit to the Mansard Gallery is worth making.

NOTES ON BOOKS

RECENT ENGLISH DOMESTIC ARCHITECTURE. 1929 Edited by H. de C. Hastings. London: the Architectural Press. 15s.

On the jacket of this book we see represented a sort of Mallet-Stevens or Corbusier house. At once our expectations are roused or our fears confirmed. But in either case we shall experience a reaction when we open the book and turn over the leaves. For it is only at the very end that anything like the house on the jacket again makes an appearance And then, on closer scrutiny, the similarity to Stevens-Corbusier work is found not to be very complete.

As the recent photographic exhibition at the R I.B.A. gallery proved, English architects are not plunging enthusiastically into the ultra-modern movement where commercial buildings are concerned. The same restraint is shown in recent examples of English domestic architecture Just as new plays woo London from an outer circle of theatres, so the new houses are making their shy *debut* on the outskirts of the metropolis Of the hundred plates in this book only about half a dozen represent anything like the twentieth-century manner

The Silver End garden village houses are not in ferro-concrete, nor is their fenestration characteristic of the European tendency to make the windows run the whole length of the building. Brick is the material used; it is colour washed, so that one wonders whether the intention is to deceive the eye. There is absolutely nothing against deceiving the eye, but the deception, if such it is, fails here. The group of four cottages is most agreeable none the less, and also cheap, their cost working out at 11d. per foot cube. In general form they are to all intents and purposes a compromise between the modern geometric and the Queen Anne styles.

But this is beginning at the end. As Mr Hastings says in his preface, " the houses have been arranged by the period in a rough chronological sequence, wherein the amateur of architecture may trace consecutively the effects of Tudor, Georgian, and modern Continental influences on contemporary thought." We start with a large and solid half-timber country house in irreproachable taste. Nor could erudition produce anything more satisfying than the house at Sandwich Bay by Mr. C. H. Biddulph-Pinchard. Those who disapprove of a great expenditure of money and ingenuity on recapturing effects of picturesque rusticity will not care for the thatched house on page 8. Its more modest tiled *vis-à-vis* perhaps just fails to charm by its very fidelity to a traditional method of panelling the walls. There results from this a stiffness which does not make for repose.

At Withington, Gloucestershire, as elsewhere, Mr. Leslie Mansfield's conservatism is shown to be justified. The vast Ayrshire mansion by Mr. James Miller is equally sober and reasonable. The design of Braydon Hall, which has affinities to the two foregoing, is more concentrated and—one would judge from the illustrations—more genial.

With two charming weather-tiled cottages, by Messrs. Imrie and Angell, and Baillie Scott and Beresford respectively, we leave the Gothic age behind and come to the stately, if somewhat complacent, renaissance house, Burdocks, by Mr. E. Guy

Dawber. The defects of 64 Park Street, page 35, are evident enough: unsatisfactory proportions and too many windows. No. 15 Church Row, Hampstead, on the other hand, is good: spontaneous without being particularly original, with excellent proportions and windows perfectly arranged.

The two examples given of Mr. Clough Williams-Ellis' work are puzzling, Caversham Place less so than the house at New Romney. Perhaps in a photograph the green-tiled mansard roof looks heavier than it does in reality. But that the house at New Romney has an air of whimsical accomplishment there can be no denying; it would be interesting to know how well it wore on increasing acquaintance. A certain apparent abruptness of colour contrasts is, perhaps unexpectedly, one of the most attractive points about Caversham Place. The proportions and spaces here are suavely elegant: not merely safe, but individual, *réussies*.

What one can see of the house, page 63, by Sir Edwin Lutyens, is of a fine four-square solidity. The same architect's house at Gullane, page 85, has a similar character, and is built on an interesting plan with a semicircular frontage.

It is a pity that no more complete view is given of the house at Sandgate by Mr. Basil Ionides than that offered by the two photographs on pp. 88, 89. There is no plan either, unfortunately.

Then with New Ways, Northampton, by Professor Behrens and W. J. Bassett-Lowke, we come to the frontiers of modernity. Mr. C. H. B. Quennell's house at Silver End, with slate roof and tall chimneys, is not going to make anyone write to the papers in alarm. But if anyone writes against Mr. T. S. Tait's Le Chateau, the defence will not be handicapped by any lack of ammunition for its artillery.

ARTIFICIAL SILK. By Ing. Dr. Franz Reinthaler, O.Ö. Professor fur Technologie, Hochschule für Welthandel, Wien. Enlarged and Revised Edition, translated from the German by F. M. Rowe, D.Sc., F.I.C., Professor of Colour Chemistry and Dyeing, Leeds University. London: Chapman and Hall, Ltd. 21*s*. net.

Recent developments in the importance of the artificial silk industry have led to the appearance of a number of text-books, amongst which the present volume occupies a prominent position. It is not a mere translation of Dr. Reinthaler's original work, published in German in 1926, but has been revised and considerably enlarged by Professor Rowe. The general intention of the book can be gathered from the author's remark: "It is indeed particularly important that those engaged in merchanting textiles should obtain a deeper insight into the development and manufacture of artificial silks, in order that they may be in a better position to understand the manifold causes to which defective goods may be due", to which Professor Rowe, in the Translator's Preface, adds: "At the present time no one concerned with textile materials, and particularly with the dyeing of them, can afford to neglect to become acquainted with such information on the manufacture, properties, uses, etc., of artificial silks as is available for publication."

The task which the authors have thus set themselves has been successfully performed. The main account of the four principal methods of artificial silk manufacture is preceded by a useful chapter on the chemical and physical properties of cellulose, and its behaviour under the influence of various conditions and reagents. The four methods themselves—viz., the nitrate, cuprammonium, viscose and acetate processes—are treated in considerable detail, and the recent modifications in the viscose process, introduced by Lilienfeld, receive due notice. A few subsidiary products, such as cellulose formates, Lilienfeld's ether silk, and thiourethane silk,

are also described; and a brief account is given of the so-called 'staple fibre' industry, in which short lengths of fibre are worked up, sometimes in conjunction with wool. The latter process attained some importance during the war, but in view of altered conditions is no longer very widely used

The properties of artificial silks next come under review, and in natural sequence an important chapter sets out the various methods of testing in vogue at the present time. In the latter connection it may be of interest to note that the fluorescence reaction under the influence of ultra violet light, though important results were expected from it, seems to have been something of a disappointment, the effects being too much at the mercy of accidental factors.

As is well known, the dyeing of the product has been found in the past to give rise to problems of extreme difficulty, which at one time threatened to impose severe restrictions on the whole artificial silk industry; these, however, have now been for the most part overcome, and the successful methods in use, in so far as they have been divulged, are fully described The manifold uses to which the final product can be put are next dealt with, though any description of the actual machines used in knitting and weaving has been judged to lie outside the scope of the book. In addition, some attention is paid to a group of other products which may be manufactured from spinning solutions, and there is also included a chapter, inevitably of a somewhat ephemeral nature, on the economic position of the industry.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 7 Automobile Engineers, Institution of, at the Merchant Venturers' Technical College, Bristol 6.15 p.m Prof W Morgan, Presidential Address, "The Member and the Institution"

Junior Institution of Engineers, at 16 St Mary's Parsonage, Manchester. Annual General Meeting Mr. H Herring, Chairman's Address on "Machine Tools, Past and Present"

TUESDAY, OCTOBER 8 . Arts, Royal Academy of, Burlington House, W. 4 30 p.m Prof Arthur Thomson, "Anatomy—The Trunk, its Bones and Muscles The Surface Forms dependent thereon in Action and Repose." (Lecture I)

Automobile Engineers, Institution of, at the King's Head Hotel, Coventry. 7 30 p.m Prof W Morgan, "The Member and the Institution"

Illuminating Engineering Society, at 15 Savoy Street, Strand, W C 6.30 p.m Opening Meeting Report on Progress in Illuminating Engineering and Exhibition of Apparatus

Marine Engineers, Institute of, 85/88 The Minories, E 6.30 p.m Mr Eskil Berg, "Electric Propulsion as applied to Passenger Liners."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne 7 30 p.m Mr S. G. Homfray, Chairman's Address.

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 30 p.m A Symposium on the Estimation of Gum in Petrol Speakers Lt-Col F J. N Auld, Dr E. W J Mardles, Dr H Moss, Mr. C R Wagner and Mr Julius Hyman.

WEDNESDAY, OCTOBER 9 Metals, Institute of, at Thomas's Cafe, High Street, Swansea 7 p.m Mr J. H Grant, Chairman's Address

Wireless Technology, Institute of, at the Engineers' Club, Coventry Street, W. 7 p.m Annual General Meeting.

THURSDAY, OCTOBER 10 . Aeronautical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W C 6 30 p.m. Mr. C. R. Fairey, "The Range of Aircraft"

Arts, Royal Academy of, Burlington House, W. 4 30 p.m Prof Arthur Thomson, "Anatomy—The Trunk, its Bones and Muscles The Surface Forms dependent thereon in Action and Repose" (Lecture II.)

Electrical Association for Women, at Aldwych House, 19 Kingsway, W C 3 p.m Mr. F F Rowley, "Electrical Cold that Keeps"

Metals, Institute of, at the Chamber of Commerce, Birmingham. 7 p.m Mr J. D North, "Metals in Aircraft Structures"

At 83 Pall Mall, S W 7 30 p.m Dr S W Smith, Chairman's Address, "Some Factors in Solidification"

FRIDAY, OCTOBER 11 Chemical Industry, Society of (Chemical Engineering Group), at Burlington House, W 8 p.m Mr J Davidson Pratt, "Rationalisation Its Meaning and Application."

Engineering Inspection, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W C 5 30 p.m Mr E. I Law, "The Chemical Laboratory in Inspection"

Eugenics Society, at Burlington House, W 8 p.m. Dr E. O. Lewis, "Mental Deficiency Present Policy and Eugenic Ideals"

Metals, Institute of, at University (Applied Science Department), Sheffield 7 30 p.m Mr F C Robinson, Chairman's Address, "Some Notes on the Selection of Suitable Metals to Resist Corrosion"

SATURDAY, OCTOBER 12 Countryside, National Conference for the Preservation of the, at the Queen's Hotel Pavilion, Ambleside 10 a.m "A Policy for the Preservation of Lakeland" Speakers Mr G L Pepler, Prof P Abercrombie, and Mr Ewart James 8 p.m "Safeguarding the Beauty of the Lake District as a National Heritage." Speakers Sir Charles Trevelyan, Prof P Abercrombie, Mr C. Williams-Ellis, and Sir Fabian Ware

L.C.C Horniman Museum, Forest Hill, S E 3 30 p.m Prof. J R. Ainsworth Davis, "Mammoth and Man"

SUNDAY, OCTOBER 13. Countryside, National Conference for the Preservation of the, at the Queen's Hotel Pavilion, Ambleside 2 p.m. "Special Aspects of Local Preservation." Speakers Mr. Hugh Walpole, Mr. H J. Massingham, and Mr. H. H Peach. 8.30 p.m (1) Dr H J. Moon, "Bird Life of the District" (2) Dr. Vaughan Cornish, "English Scenery."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

PROCEEDINGS OF THE SOCIETY.

ALDRED LECTURES.

NOMADIC MOVEMENTS IN ASIA.

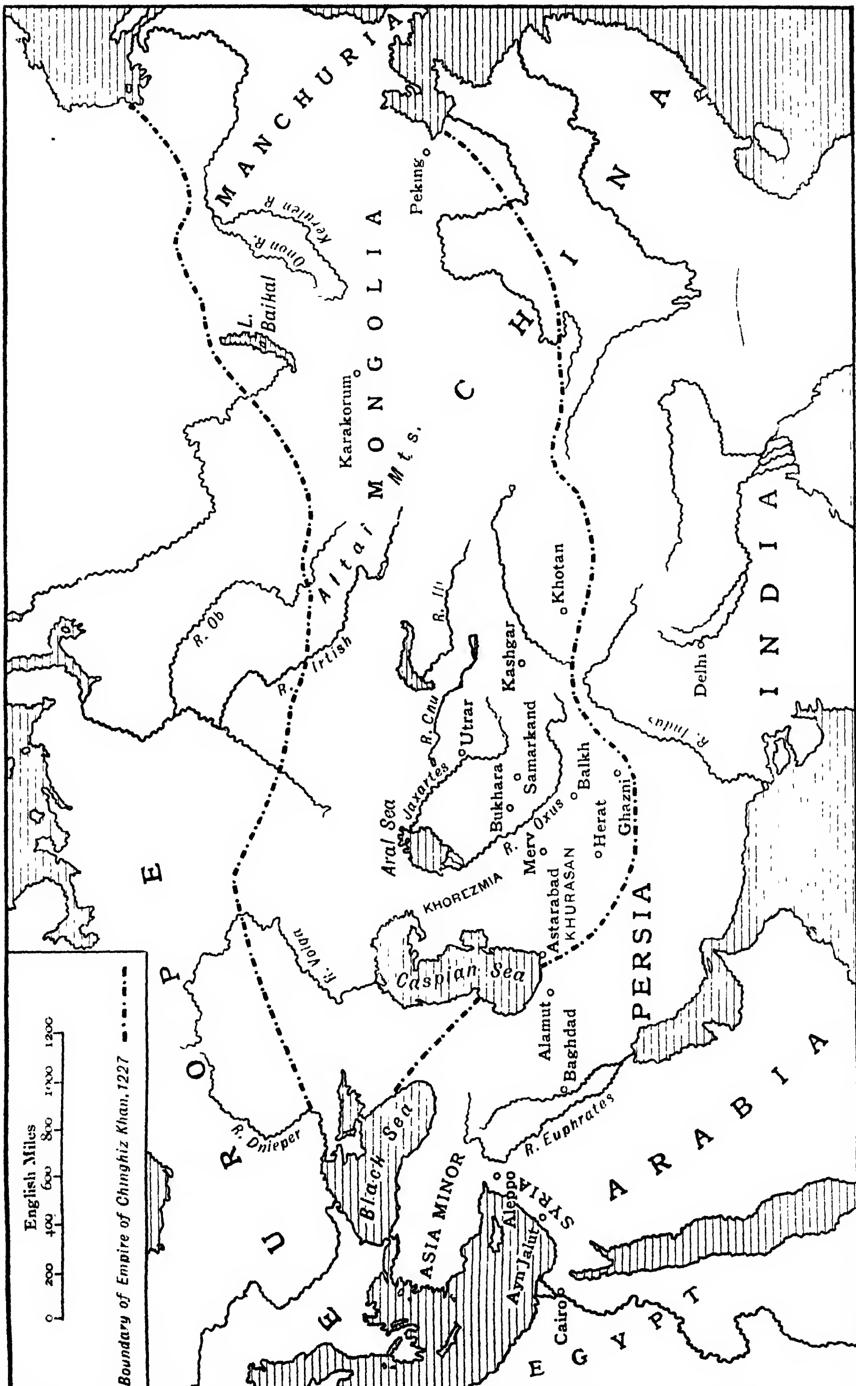
By Sir E. Denison Ross, C.I.E., Ph.D.,

Director of the School of Oriental Studies, and Professor of Persian, University of London.

Lecture IV.—CHINGHIZ KHAN AND THE MONGOLS.

(*Delivered May 13th*, 1929).

In this, the final lecture of my course, I shall deal with the invasion of China and Middle Asia by the Mongols during the 13th century. It would take me outside the limits of this lecture if I were to dwell on the Mongol invasion of Europe. Although the migration of the Mongols was on an infinitely larger scale than the three movements of which I have already spoken, its influence on Asia has been less lasting than that of the others. The influence of the Arabs, for example, is ever before us in the wide-spread profession of Islam; the westward movements of the early Turks paved the way for the later supremacy of the Seljuks, which, in its turn, led to the subsequent domination of the Middle and Near East by the Ottomans. Mongol rule in Persia lasted barely 80 years and the Yüan dynasty in China rather less: and it is only in Southern Russia that we can readily detect to-day the ethnic results of the Mongol invasions, for it was in Russia and not in Asia that the descendants of Chinghiz Khan ruled for the longest period.



Map of Central Asia shewing the boundaries of the Empire of Chinghiz Khan.

The name of Chinghiz Khan is commonly associated with the terrible invasions of Persia and Eastern Europe which were carried out by the forces which he had set in motion in the 13th century. It was in reality his grandson Hulagu who turned Baghdad into a smouldering charnel house, and it was another grandson, Batu, who invaded Europe. Chinghiz Khan himself never journeyed further west than the Oxus or further South than the Indus. During his active career, extending over fifty years, he was fully occupied with the unification of the Tatar tribes, the conquest of Northern China and the overthrow of the powerful king of the Eastern Provinces of the Islamic world. It was another grandson, the famous Kubilai Khan, who completed the conquest of China, and founded the dynasty of the Yuan, which endured for seventy-five years (1257-1332).

Harold Lamb, in his popular account of Chinghiz Khan, thus summarizes in a few words the career of his hero: " A Mongol nomad who had never seen a city, founded an empire that ruled half the world; a hunter and herder of beasts outmanœuvred and crushed the armies of three civilizations; a barbarian who did not know the use of writing made a code of laws for fifty peoples."

Chinghiz was something more than a ruthless barbarian at the head of countless savage horsemen, and though he and his successors carried destruction and desolation into the fairest lands of Asia on an unprecedented scale, what he achieved in unifying his empire, in organising his administration, and in codifying his laws, entitle him to unstinted admiration. As a world conqueror he does not yield in eminence even to Alexander the Great; as a legislator he may fitly be compared to Napoleon, as an administrator he showed a wonderful broad-mindedness in choosing the right men to serve him no matter what their nationality, as a general he was never out-manoeuvred and as a soldier he was the bravest of the brave. It is none the less astonishing that a man who displayed such gifts of statesmanship, foresight, love of justice and real tolerance should have spread over half Asia the stillness of a churchyard. How can we account for his inhuman savagery? and whence did he derive the ambition to conquer all the world? He had nothing to preach, for the Mongols, unlike the Arabs, had no slogan, no new culture to offer the conquered peoples, nor did he care for the things those conquered peoples possessed.

If we consider for how many centuries the various hordes of nomads had hovered on the Northern frontiers of China, without ever making any movement on a really large scale, we shall better realize the outstanding importance of the part played by this extraordinary man. All previous movements, whether towards China or towards the Middle East, seem like so many aimless wanderings or haphazard raids which only took definite shape with the chance appearance of a great leader. With Chinghiz the case is different; for he seems from the first to have been inspired by a definite desire to conquer the whole world; with the sole object of getting other nations to provide for himself and his

family. But how, one asks, did a man, brought up in the simple environment of a nomad camp suspect the wide extent of Asia ?

He, of course, considered the organisation of his empire only from the point of view of nomad conquerors dominating civilized peoples. And what can have given birth to this spirit of World-conquest in this nomad chieftain ? His whole life was devoted to this one aim, and so powerful was this spirit in him that it seemed to survive his death and to pass as a natural heritage to his very numerous sons and their descendants. Though he cared nothing for human life, he cared a great deal about law and order.

I fear I cannot, in this lecture, indulge in the anecdotal side of the career of Chinghiz Khan, for I am only concerned with him as the leader of his people and not as a hero of romance. It is interesting to consider how Chinghiz Khan came to enjoy such popularity in the West. How so much romance attaches to his name that any popular work written round it is at once assured of a market. When did this taste for Mongolia in the Middle Ages first manifest itself ? Marco Polo, who also makes a best seller, belongs to the same land and age. The only pity is that scholars have not the time for writing popular books, and that consequently the writers of them know nothing of the sources and never seem to know where to find the best information, thus leading the public astray. Now the sources are exceptionally plentiful. First of all there are the Chinese histories of the Yüan dynasty, which tell us about his early career and his conquest of Northern China, but very little of his achievements in the West ; and secondly the Persian histories ; and thirdly the Mongolian histories, which are mostly legendary. The monumental *History of the Mongols* by Sir Henry Howarth, though a mine of information, is actually only a compilation of second-hand sources, mainly French and Russian. By far the most important account of Chinghiz Khan in English is to be found in Professor Barthold's *Turkestan down to the Mongol Invasion* (Publications of the Gibb Trustees, New Series, Vol. V, 1928).

Certain writers on Mongolian history have held that if Chinghiz had not achieved the confederacy and overlordship of the Mongolo-Turks, circumstances were such that one of his rivals would probably have done so ; for times were obviously ripe for the unification of these peoples.

In order to understand the career of Chinghiz Khan we must know something of the state of affairs in China at the beginning of the twelfth century. The anarchy which followed the fall of the T'ang dynasty in 906 gave the opportunity for a Mongolian tribe known as the Ch'i-Tans or Khitaïs (whence our word Cathay) who had recently conquered Manchuria to invade Northern China. In 963 Southern China was brought under the rule of the Sung dynasty, who had to protect their frontiers, not only against the Khitaïs in the North, but against the Tunguts in Kan-Su. During the greater part of the eleventh century the Khitaïs and Sung rulers lived in peace. In 1114, however, a Manchu people called the Jurchen, who were vassals of the Khitaïs, revolted, and having driven

their former masters out of Northern China, founded a dynasty known as the Chin or Golden, with their capital at Peking. The chief of the Khitaïs, Ye-liu-ta-shih, fled with his people from China and, after years of wandering, arrived in the country of the Uighurs, in the Ili basin, who had been his vassals, and now received him as their over-lord. In the course of the next few years he conquered Kashghar and Khotan, destroying the power of the local dynasty of Kara-Khanids. He also made the Khwarazm Shah, Atsiz, his tributary, and captured Transoxania; finally, in 1141, he defeated the Seljuk Sultan, Sanjar, at Katwan, in the famous battle to which I referred in my previous lecture. He was now proclaimed Gur-Khan, or universal lord of the Turks, and his newly-founded dynasty is known as the Kara-Khitaïs. His kingdom now comprised all the lands of the Turks, from the country of the Uighurs to the Sea of Aral. He made Bala Saghun on the Chu river his capital. This empire lasted down to 1211, when their power was destroyed by the Khwarazm Shah.

At the time when Ye-lui ta-shih was forming his new Turkish empire in the West, the Tatars of Mongolia were rapidly growing in strength and were causing much anxiety to the Chin Emperor. One of the most formidable of these peoples were the Keraïts, a Turkish tribe who had been converted to Christianity by the Nestorian bishop of Merv in the eleventh century. Among the vassals of the Karaits who aided them in their wars against the Chin was a confederacy numbering upwards of 30,000 families inhabiting the prairies round about the Onon and Kerulen rivers. The head of this confederacy was a certain Yisugai who married the daughter of the Karaït prince, by whom was born to him a son named Temujin, afterwards known as Chinghiz Khan.

On the death of Yisugai in 1167, Temujin, who was twelve years of age, was considered too young to succeed his father, and the King of the Taijiut was elected as chief of the confederacy. The active career of Temujin did not begin until twenty-one years after his father's death; not that the young man was idle during these years; on the contrary he was, with the wise counsel of his mother, steadily paving the way for his future career; and always watchful for the moment when he should be strong enough to seize the leadership of the confederacy, from which he had been excluded by reason of his tender age. Temujin, during these years managed to retain personal independence with only a very small following, but in 1188 this following had attained such large numbers that he felt strong enough to give battle to his rivals the Taijiuts. In the fierce contest which ensued, Temujin owed his victory of 13,000 over 30,000 men to his tactical skill, and with it began his triumphant career as a conqueror. His next task was to subdue the Merkits who lived round the lower shores of lake Baikal, and during the next four years he was engaged in constant warfare with them without any conclusion being reached.

Temujin was a vassal of the Keraït Khan. In 1203 a Mongol named Jamuka, who had been blood-brother (*Anda*) to Chinghiz and had subsequently turned

against him, took refuge with the Keraits and managed by intrigue to turn the Keraits against Temujin, and open war was declared. This put Temujin for the first time in a position of real independence ; and in a fierce battle which ensued, the Keraïts were utterly defeated, and their king fled to the king of the Christian Naimans, while the Keraits themselves surrendered body and soul to Temujin.

In the following year Temujin attacked the Naimans who occupied the Southern plains of the Altai range, and were vassals of the great Kara-Khitaï Emperor. With the defeat of the Naimans (1206), Temujin had made himself real lord of Mongolia. The Khan of the Naimans was killed, but his son, Kuchluk, escaped and fled to the Gur-Khan of the Kara-Khitais, whom he succeeded in 1212 It was only after the subjugation of the Naimans that the transaction of business in writing was instituted by the Mongols. A Uighur who had been the keeper of the seal to the Naiman Khan, was appointed to the same office by Chingiz, and was commissioned to teach reading and writing to his sons. The Uighurs thus became the first counsellors of the Mongols in their new capacity of a world state, and it is impossible to overestimate the important role they played in consolidating the Mongol Empire.

In 1206 Temujin held a grand *Kuriltai* of all the chiefs, at which he received the titles of *Sutu Bogdo* " Son of Heaven," and of Chinghiz, whence the name of Chinghiz Khan by which he has ever since been best known. (The real meaning of this title has not yet been discovered). Some further trouble from the Naimans and Merkits was disposed of without much difficulty. In the South West, Chinghiz was recognised by the *iduqut* of the Uighurs, who had been vassals to the Kara-Khitais (1209). Finally the Karluks and the Kirghiz submitted (1218).

Having thus effected the unification of the Tartars, Chinghiz turned his attention to the Tanguts of Kansu (1205-09). He aided the Ongüts and the Ch'i-Tans in their revolt against the Kin—and by 1215 the Mongols had possessed themselves of the Kara-Khitai Empire, and had revived the old Turkish State.

According to the *Chin Shih*, Chinghiz was tributary to the Chins down to 1211, when he withdrew his allegiance and made his first eruption into Northern China.

The conquest of Northern China was a very long and difficult task. for the Chin Manchus were a loyal and devoted people and offered the most stubborn resistance. It required 4 years for Chinghiz to capture Peking, which finally fell in 1215, and another three to subdue the rest of Northern China.

Seeing that my subject is the westward migration of the Mongols, I cannot dwell on the campaign in China.

After the fall of Peking, Chingiz again turned his attention to the Turkish tribes bordering on the Islamic provinces of Khorezmia and Transoxania, the Uighurs, the Karluks and the Kirghiz. Presumably for strategic reasons

he now transferred his capital from Karakorum to Bala Saghun on the river Chu, the former capital of the Gur-Khan of the Kara-Khitaïs.

It is at this point necessary to introduce the Khwarazm-Shahs, who by the end of the twelfth century had become masters of nearly the whole of the Empire of the Great Seljuks.

The famous battle of Katwan in 1141, was the result of an appeal made by Mahmud Khan, the Kara-Khanid king of Transoxania, to Sanjar for help against the encroaching Karluks, who in turn had invited the aid of the Kara-Khitaïs. The Khwarazm Shah at this time was, as we have seen, a vassal of the Kara-Khitaïs, this fact did not hinder him from carrying his armies into the West and the East, and 'Ala ud-Din Muhammad, who reigned from 1200 to 1220, by the year 1214 had made himself master of Khurasan in the west, had driven the Kara-Khitaïs out of Transoxania and had captured Balkh, Herat and Ghazna in the South. Sultan Muhammad in 1215 turned northwards to attack the Kipchaks, and it was in this campaign that he first came in contact with the Mongols, then pursuing the Merkits who had fled westwards. It is important to realise that this encounter did not in any way affect the relations of the Khwarazm-Shah with the Mongols, as will be seen from the exchange of friendly embassies which now followed.

In 1216 the Sultan, having learnt the news of the fall of Peking, sent an embassy to Chinghiz Khan, probably with the object of finding out more about this great conqueror. Chinghiz received the envoys well, and told them to inform their master that he regarded the Khwarazm-Shah as the ruler of the West, and himself as the ruler of the East; that he wished to remain on peaceful terms with him and to encourage free intercourse of merchants between their two countries. This would go to show that at this time Chinghiz was not dreaming of world-wide dominion; and certainly did not contemplate invading the Sultan's territories.

In 1218 Chinghiz sent a return embassy which was received none too graciously by the Sultan (probably in Bukhara); with a proposal for an alliance, or at least a regular commercial treaty. To this the Sultan, after some hesitation, agreed, though he was unwilling to recognise the supremacy of the Mongol Khan. Either simultaneously, or very shortly after the embassy, Chinghiz had sent a caravan of four hundred merchants to Khorezmia. On reaching the frontier port of Otrar, near the Jaxartes, these merchants were plundered and put to death by the local governor, and although it appears that the Sultan was in no way responsible for this wanton and cruel act, war between the two rulers was now inevitable. Before opening hostilities, however, Chinghiz sent three envoys to ask satisfaction for this outrage; one of these envoys was put to death by the Sultan's orders and the other two were sent back after having their heads and beards shaved.

War was now inevitable: but had not such a good excuse been offered to Chinghiz it was obviously only a matter of time for him to turn his attention

to these rich neighbouring lands, and the weakness of Sultan Muhammad's kingdom must sooner or later have proved an irresistible temptation to the mighty conqueror. We cannot therefore put the blame entirely on the Khwarazm Shah for the westward march of the Mongols, still less can we accept the suggestion made by a Muslim historian that the Caliph of Baghdad had invited Chinghiz to attack the Sultan, of whose power he was jealous.

In 1219 Chinghiz set out from his headquarters at the head of the largest force he had yet employed in one campaign, accompanied by his four sons. Seeing that a large force had to be left to continue the war in China, which had by no means ended with the fall of Peking, the actual Mongolian troops with Chinghiz have been estimated by Prof. Barthold at 70,000. To this number must be added the subjected peoples, including many Muslims, bringing up the total to about 200,000 men. The forces at the disposal of the Sultan were probably twice that number, mostly mercenaries. Professor Barthold thus describes the method of warfare always adopted by the Mongols in settled lands: "Everywhere the defenceless inhabitants of the villages were driven in large numbers to assist the Mongols in besieging the fortified towns; in storming fortifications the Mongols used to drive these unfortunate wretches in front of them so that they received the brunt of the hail of arrows and prepared the way for the army following them."

By the end of 1219 Chinghiz had established himself firmly in Transoxania, having captured both Bukhara and Samarkand. Chinghiz himself did not travel further west than Bukhara. The Sultan fled ignominiously into Northern Persia and managed to elude the pursuing Mongols. Finally he took refuge in an island of the Caspian, not far from the modern Astarabad, where in the following year he died in utter destitution. His valiant son Jalal ud-Din continued the unequal struggle, which ended with his defeat by Chinghiz on the banks of the Indus in 1221. For the Mongols had turned southwards and reduced to ruins Herat and Ghazna. It was while Chinghiz was resting on the banks of the Indus that he received news of a revolt in the north of his dominions which caused him to retrace his steps.

After spending a few months on the Indus, he returned by the way he had come and wintered in Samarkand. It was on this return journey that he was met by the Taoist priest, Ch'ang Ch'ung, whom he had invited to come and discuss with him religious matters. Ch'ang Ch'ung, accompanied by a Keraït Christian Chingay, set out to find the conqueror at the beginning of 1219, when Chinghiz was still on the Irtish, and only overtook him nearly three years later in the neighbourhood of Samarkand. The narrative of this holy man's journey, told by one of his diciples, is a document of the greatest interest and gives us a wonderful picture of China and Turkestan in the thirteenth century. The account of Ch'ang Ch'ung's first interview, through an interpreter, with the Emperor is worth quoting. The Emperor said: "You have come to see me, having travelled 10,000 li. I am much gratified." The Master

answered: "The wild man of the mountains came to see the Emperor by order of his Majesty. It was the will of heaven." Chinghiz invited him to sit down and ordered a meal to be set before him. After this he asked: "Sainted man, you have come from a great distance. Have you a medicine for immortality?" The Master replied: "There are means for preserving life, but no medicines for immortality." Chinghiz lauded him for his sincerity and candour, and, by imperial order, two tents were pitched for the Master east of the Emperor's tents.

The next three and a half years he spent in and around Transoxania. News of a revolt of the Tunguts made Chinghiz, in 1225, withdraw to the East, never again to turn his face Westward. It was while setting out on a fresh expedition into China, at the end of 1227, that he died at the age of seventy-two, an old and tired man. The funeral escort that bore his body to its final resting place put to death every person that they met—as was the Tartar practice—possibly so that the great Khan's burial place might not be divulged.

The history of the dynasty reports that when he felt death was approaching he thus addressed those gathered round him: "The best troops in China are those of T'ung Khan, but owing to their geographical position it is hard to surprise them," and proceeded to describe a stratagem whereby these people might be drawn out, and, being fatigued by a long journey, be open to attack, "*Then we can certainly destroy them.*"

In these dying words we see the undying love of conquest and destruction which possessed this most gifted and most brutal of conquerors even at the moment of death.

And now for a period of thirty years Central Asia was spared further horrors. It was during the reign of Chinghiz Khan's son, Ugedei, that the invasion of Central Europe took place, and it was only the death of this prince in 1241 that saved Europe from being entirely overrun by the Mongol hordes. In 1248 another grandson of Chinghiz Khan, named Mängü Khan, succeeded to the overlordship of the Mongols, and it was he who again set in motion fresh western campaigns, and for the special subjection of the western lands of Islam he appointed his brother Hulagu, who crossed the Oxus in 1253 at the head of some fifty or sixty thousand men. Such had been and still was the state of disorder and anarchy in Persia since the last Mongol invasion that Hulagu was actually met and welcomed on Persian soil by a number of local princes and governors, and his response to this invitation offers another example of that extraordinary mixture of destruction and good government which characterised Mongol rule.

One of Hulagu's first acts was the destruction of the great stronghold of the *Assassins*, Alamut. Marching through Persia by slow but sure degrees, he finally reached Baghdad on January 18, 1258. Many descriptions have come down to us of the terrors of the sack of Baghdad and the destruction of her buildings, the slaughter of her inhabitants, and the murder of the Caliph.

Without quoting any of these I would like to mention two anecdotes which illustrate the terror which the Mongols inspired. These men rode about on little ponies, their toes almost dragging on the ground, armed only with bows and arrows. It was said that a single Mongol would enter a village, wherein were many people, and would continue to slay them one after another, none of them daring to raise a hand against this horseman. Another Mongol, having taken a man captive, but having no weapon wherewith to kill him, said: "Lay your head upon the ground and do not dare to move," and he did so, and the Tatar went and fetched a sword and returned and killed him.

A Persian related the following: "I was going with seventeen others along a road and there met us a Tatar horseman, who bade us bind one another's arms. My companions began to do as he bade them, but I said: 'He is but one man, why should we not kill him and flee?' They replied: 'We are afraid,' and not one of them dared to move, so I took a knife and killed him."

There still stands in Baghdad to-day a beautiful minaret-shaped tower, which, the latest researches seem to prove, was built by Hulagu himself! It is interesting to note that the chief commander of Hulagu's forces at this time was a Christian Nestorian named Kit Buka; moreover, Hulagu had himself married a Nestorian lady named Dokuz Khatun, who was the grand-daughter of the last King of the Keraits, Wang-Khan Tughril.

Having thus completed one of the most terrible deeds recorded in the history of the world, Hulagu continued his western march in the hope of subduing the remaining Muhammadan states. Crossing the Euphrates he carried havoc and slaughter into Mesopotamia and Syria. In Aleppo alone he put 50,000 people to the sword. But even the Mongol resources in men were nearing an end; for at the same time they were fighting in China and Southern Europe; and Hulagu now at last met an enemy who was prepared to stand up against him in the person of the Mamluk Sultan Baybars. In 1260 on the field of Ayn Jalut near Nazareth, the Mongols met with their first defeat, and Egypt, Syria, Arabia and Asia Minor were saved from sharing the fate of Baghdad.

In 1259 Mangu Khan was succeeded by his brother, the famous Kubilai Khan (of Xanadu fame) who shortly after conferred on Hulagu the title of Il-Khan, or Provincial Khan, of Persia, a name by which the dynasty of Hulagu and his successors is known.

Hulagu dying in 1265 was succeeded by his son Abaqa, who also suffered a defeat at the hands of Sultan Baybars in 1277.

The Mongols had hitherto shown themselves tolerant towards all religions, except Islam. Chinghiz Khan professed Shamanism, and his wife was Christian. They had, however, like the Seljuks, been quick to appreciate the administrative genius of the Muslim Persians, and gathered round them men of science, poets and historians, and the 60 years of Il-Khanid rule in Persia was rich in literary achievement. The wonder is that those cultivated Persians like Juwayni and Rashid ud-Din, the administrators and historians, could bring themselves

to serve the men who had laid waste their country and destroyed so many libraries.

A similar case is offered by the willing service rendered to the unlettered Seljuks by men like the Vezirs al-Kunduri and Nizam ud-Mulk who were also both historians.

During the rule of the Il-Khanids (1295-1304) Persia enjoyed something more nearly approaching peace and quiet than she had known for centuries. The accession of Ghazan the Seventh Il-Khanid, who adopted Muhammadanism with strong Shi'ite proclivities, marks the definite triumph of Islam over Mongol heathenism and the beginning of the reconstruction of Persian independence. His conversion was regarded with disfavour by many of the Mongols, and led to rebellions which Ghazan suppressed with a ruthless hand.

He was constantly engaged in war with the Mamluks of Egypt with varying success, but finally in 1303 his forces were utterly defeated by the Egyptians, and one can picture the exultation of the inhabitants of Cairo when they beheld, being led through the city as prisoners, 1600 of these terrible Mongols, each bearing slung round his neck the head of one of his dead comrades. Ghazan never recovered from the vexation and shame of this defeat, and died in the following year. E. G. Browne thus writes of him in his *Persian Literature under Tartar Domination*: "The mourning for his death throughout Persia was universal, and appears to have been sincere, for he had restored Islam to the position it occupied before the invasion of Chingiz Khan, repressed paganism and reduced chaos to order . . . . He was devoted alike to arts and crafts and to the natural sciences, especially to architecture on the one hand and to astronomy, chemistry, mineralogy and botany on the other. He was extraordinarily well versed in the history and genealogy of the Mongols, and besides Mongolian his native tongue, was more or less conversant with Persian, Arabic, Chinese, Tibetan, Kashmiri and, it is said Latin. . . . Previous Mongol sovereigns had, in accordance with the custom of their nation, always taken measures to have the place of their burial concealed. Ghazan, on the other hand, specified the place where he should be buried, and spent large sums in erecting and endowing round about his mausoleum a monastery for dervishes' colleges, a hospital, a library, an observatory, a philosophical academy, etc. etc."

It is indeed curious to contrast this passage with those relating to the sack of Baghdad, and to realise that less than fifty years after the merciless destruction of all that Islamic culture stood for by Hulagu, his great grandson should as a devout Muslim devote so much time and money to precisely the contrary object, though Ghazan could not of course bring back the dead to life !

Ghâzân was succeeded in 1305 by his brother Uljaitu, who had been baptised into the Christian Church as a child, but was afterwards converted to Islam by his wife. He corresponded with various European courts, and some of the letters on both sides are extant, but he seems to have hidden from Pope Clement

V, Philip le Bel and Edward II the fact that he had renounced Christianity.

I have now reached the end of my lectures, but I fear that the ground which I had hoped to cover could not fittingly be compressed into the allotted space. I shall, however, be satisfied if I have succeeded in giving you some idea of these great semi-military migrations which form the outstanding landmarks in the history of Central and Middle Asia between the rise of Islam in the VII century and the fall of the Baghdad Caliphate in the XIII. Although I have avoided as far as was possible the introduction of unfamiliar names, I fear their number is great. There is, however, no reason why such names should remain unfamiliar to us, for our knowledge of history should certainly include that of Asia, and there is no reason why Oriental heroes and the geography of Asia should not become part of our general knowledge.

NOTES ON BOOKS.

UNEMPLOYMENT: ITS CAUSE AND CURE; AN ENQUIRY AUTHORISED BY THE GENERAL FEDERATION OF TRADE UNIONS. Summarised by W. A. Appleton, General Secretary. London: Philip Allan & Co., Ltd. 5*s*. net.

The summarist, Mr. Appleton, in a formal presentation to his Federation (pp. V-VII), mentions nineteen persons who have helped by taking direct or indirect part in the production of this book; and expectancy may be stimulated by the hope of something exceptionally exact, pertinent and profound, as being the joint effort of twenty select individuals.

The text commences on p. 1 with a somewhat impertinent truism:- "The fact of unemployment needs no demonstration." We have discursive items till we reach the middle of p. 3, where we read of the prominent place now given to "repeated assertion." After this the actual subject matter of the book comes well to the front in an effort to instruct the reader as to "what is meant by causes." We are told that some of the helpers did not "clearly understand that causes are antecedents invariably and unconditionally followed by certain effects."

Mr. Appleton appears here to be solving lightly and assertively a problem which has baffled thinkers through the ages. Let us make an application of his doctrine. One may say that for us non-polarites night invariably and unconditionally follows each day; therefore night is the cause of day. Another may similarly argue that day is the cause of night. Thus we arrive at a contradiction or an absurdity, and the doctrine of sufficient reason, as used by Leibnitz, gives us no help in making a choice. In addition, Mr. Appleton, who seems to think that he holds the key to the problem of the ages as regards causation, refers vaguely on p. 3 to "—the modern conception of various causes combining—"; but he does not seem to accept that doctrine which comes first from a thoughtful study of the calculus. This doctrine is that summation can only be exactly or usefully applied to such factors, data, features, elements or subjects as possess some inherent and definitely measurable aspect of quantity common to all of them; a doctrine often lost sight of in our day.

The concluding chapter, pp. 162-182, is termed an appendix, and it treats of "Foreign Exchanges in relation to Unemployment." The author, Mr. R. F. Harrod, is introduced to us on p. vi as one who attended early discussions, but

whose University work at Oxford prevented further attendance. Mr. Harrod lucidly, pertinently and concisely discusses the factors which make sudden and considerable variations in foreign exchange so embarrassing in relation to contracts and manufactures, pp. 163-164. Further, on page 164, he commences a useful study of depreciation as affecting local and foreign trade ; much tabulated matter of importance following. This chapter by Mr. Harrod, with a few additional notes and references, would make a useful booklet for business men, the clear, concise and exact style being an important consideration.

Chapter VII, "The Effects of War," pp. 73-86, offers some difficulties, owing to the two senses in which the term war is understood by Mr. Appleton's helpers, (1) International Fighting ; (2) Strife between Capital and Labour. It is, however, tolerably evident that in most cases our summarist soon breaks away from the bonds, and expresses his own view ; also, as far as we grasp his view, it is that (1) and (2) are fundamentally similar. The danger of any such view appears to rest in an ultimate expression which may put private disputes into parity with inter-state warfare.

Mr. Appleton tells us that remedies for both aspects of warfare are similar, and he illustrates this by reference to the great dispute in the coal industry ; "humanity," "ethical education," also other virtues of like kind, leading to arbitration rather than fighting.

MOUSEION. Bulletin of the International Institute of Intellectual Co-operation. April number. Paris. 16 *francs*.

The museum staffs of the world form, as it were, a cadre of civilisation. They are mostly not well paid for their services, which are not on that account given grudgingly.

There has always been less rivalry of a hostile hind in the intellectual field than in any other, but the Institute of Intellectual Co-operation is not superfluous. *Mouseion*, which appears three times a year, in April, September and December, should be welcomed as providing a voice for that body of men of learning and taste the weight of whose prestige is the measure of the community's enlightenment.

Mouseion has the agreeable format, feel and appearance of a high-class French review. The contents of the April number range from descriptions of museums in places so far apart as Cardiff and Albania to analyses of methods for subjecting pictures to scientific examination. There are four main heads : *La vie des Musées, la technique des Musées, les catalogues des Musées*, and a report of the proceedings of the *Office International des Musées*. The articles are illustrated by eight plates.

One of these shows the experiment on artificial lighting that is being made by the Ryjksmuseum at Amsterdam. The picture chosen for the purpose is Rembrandt's so-called *Night Watch*. Here is a proper setting for a masterpiece, and an example to be followed. The most famous, the noblest picture in Belgium is crowded into the corner of a church, barricaded by a stall laden with photographs of itself, so placed that one half of the panels are bathed in sun while the other half are plunged in shadows, and finally, is the subject of a kind of abbreviated lecture in a bewildering succession of tongues.

M. André Blum's article on the scientific examination of pictures is most interesting, though, as he says, science cannot go so far as to give the critic "des solutions toutes faites et définitives." Before the seventeenth century it was the rule for painters to know the chemistry of their technique. Certain fine qualities are hardly to be expected in the work of artists who rely too much on their colourman.

There is an interesting note under the heading of the U.S.S.R. There are now

six hundred small museums in Russia made up of accurate copies of works of art, which are produced in Leningrad under the supervision of the *Direction générale des Sciences.*

CATALOGUES OF WALL PAPERS. Victoria and Albert Museum. 3s.

Not only is this catalogue illustrated, it also contains an introductory historical essay by Mr. C. C. Oman, in which the evolution of wall papers is most interestingly described.

Like mankind, wall papers do not progress with any inevitable steadiness They too have had their ups and downs. Owing to their recent " down " they have been in disgrace with the mass of less affluent people of taste, who have blotted them out with distemper But there are signs of a renaissance. Artists are again applying their talent to making designs for wall papers as for everything else that pertains to the machine-produced interior

Among the most agreeable of these contemporary designs are direct imitations of marble, for use, admittedly, in a sophisticated environment. Now, as Mr. Oman says, " at no time has the inspiration of wall-paper been entirely original " At first textiles and wall paintings were imitated ; later, sculpture, stucco-work and panelling ; later again, leather-work Technical limitations were by no means artistic limitations ; indeed, it is only when technical progress had outstripped workmanship that there came that "orgy of complicated designs," the litter from which has not been cleared up to this day.

" The Gothic revival must bear the blame for the production of some of the most offensive designs " ; but some of the early " original " designs for nursery paper were no better. " If the artistic taste of children can be ruined in the nursery, a paper such as No 66 (V. & A) . . must be held responsible for many intellectual murders." The tide turned again in the sixties, when the influence of William Morris began to be felt in this as in other departments of craftsmanship.

An amusing sidelight on the seventeenth century is offered by a quotation from a letter from the Bishop of London to the Warden and Masters of the Stationers' Company, in which the Bishop requires them to " . . . Damask or obliterate whatsoever Sheets you have seized of a book called Leviathan . . ." Damasking was printing designs : in fact the usual way of dealing with censored books in those days was to turn them by damasking into wall papers or box linings.

Mr. Oman discusses both French designs and those Chinese papers for which there was a strong taste in England from about 1740 till about 1790. By this time Réveillon and others had brought the art of colour printing with wood blocks to perfection ; and what with heavy customs duties and the vagaries of fashion to contend against, the Chinese papers disappeared from the market.

NATIONAL PROGRESS OF PERU.

In the introductory remarks to his Report on the Commercial, Economic and Financial conditions in Peru, H.M. Consul at Callao states that after a century as an independent nation, marked by revolutions, disturbances and international strife, Peru has suddenly emerged from this fluctuating existence, and, standing at the threshold of a new era, now commands attention as one of the coming republics of South America. The recent recognition of her national rights accorded to her by the International Plebiscitary Commission at Arica, in connection with her long-standing dispute with Chile, has served to emphasise her status. It is almost

incredible to those who knew the country before 1920 what progress has been achieved in the last few years under a stable government and a uniform political administation dedicated to a definite plan of national rehabilitation. With the rights of property guaranteed, and respect for those rights enforced, public confidence has been restored, and the nation as a whole has rallied to the support of the government in the realisation of its constructive programme.

New highways have been built, new buildings erected; new mines and oil wells opened up, new irrigation works and new railways commenced, new industries started; at the same time agriculture has been stimulated, national defence improved, and the health and general well being of the people provided for by new sanitation works in most of the principal cities. Yet these improvements have not been brought about without considerable cost, and there are many who think that they have been undertaken on too great a scale in proportion to the wealth of the nation, and at too fast a pace in relation to its means and capacity to pay. The public debt has more than doubled in the last five years, and indirect taxes, either in the form of import dues or consumption duties, bear heavily on the people. There are few articles of common consumption, even though of domestic origin, such as matches, sugar, salt, tobacco, gasoline and beer, that do not include in their selling price a heavy proportion of public tax; and almost all imported articles, including wheat, flour, rice, and other necessities of life, are similarly subject to heavy customs duties. There is scarcely any article of commerce in Peru or any enterprise that is not made to pay its toll to the Government, and new schemes are constantly being sought for the creation of further revenues to keep pace with increasing expenditure. At such a rate the point of exhaustion must soon be reached, especially in relation to the poorer classes, and other means of raising revenue sought, or else expenditure curtailed.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 14. Automobile Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Prof. W. Morgan, "The Member and the Institution."

Brewing, Institute of, at the Charing Cross Station Hotel, Strand, W.C. 7.15 p.m. Messrs. E. B. Collier and F. E. B. Moritz, "The Season's Malts (made from 1928 Barleys)."

Heating and Ventilating Engineers, Institution of, at the Borough Polytechnic, Southwark, S.E. 7 p.m. Mr. F. F. Powell, "Vacuum Cleaning."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Sir Josiah C. Stamp, Presidential Address.

University of London, at Birkbeck College, Bream's Buildings, Fetter Lane, E.C. 5.30 p.m. Prof. L. L. Schücking, "Puritan Traits in English Civilisation." (Lecture I.)

At Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Geyl, "The Revolt of the Netherlands." (Lecture I.)

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Brocklehurst, "Secretion of the Digestive Juices." (Lecture I).

At King's College, Strand, W.C. 5.30 p.m. Dr. Prof. A. Hevesi, "Great Figures of Hungarian Literature." (Lecture I.)

At King's College, Strand, W.C. 5.30 p.m. Rev. G. E. Newsom, "The Church and the World." (Lecture II).

At the London School of Hygiene and Tropical Medicine, 37 Torrington Square, W.C. 6 p.m. Prof. Dr. T. J. M. Madsen, "Seasonal Variations of Epidemic Diseases."

At University College, Gower Street, W.C. 2 p.m. Prof. J. E. Neale, "England in Shakespeare's Day." Lecture I. "Elizabeth and Her Court."

At University College, Gower Street, W.C. 5.30 p.m. Prof. K. Fajans, "Chemical Forces and Atomic Structure." (Lecture I.)

TUESDAY, OCTOBER 15. Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, "Anatomy—The Trunk, its Bones and Muscles. The Surface Forms dependent thereon in Action and Repose."

Chadwick Public Lecture, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8.15 p.m. Mr. Arthur J. Martin, "Sewage and Sewage Disposal." (Lecture I).

Metals, Institute of, at 39 Elmbank Crescent, Glasgow. 7.30 p.m. Mr. H. H. A. Greer, Chairman's Address.

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m.

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Lecture by Mr. J. Pike.

University of London, at Bedford College for Women, Regent's Park, N.W. 10 a.m. Miss Johnson, "Uncle and Nephew in Old French Epic and Romance."

At Bedford College for Women, Regent's Park, N.W. 12 noon. Miss Ellis-Fermor, "The Rise of the Drama."

At Bedford College for Women, Regent's Park, N.W. 12 noon. Miss Tarrant, "History of Greek Philosophy."

At Bedford College for Women, Regent's Park, N.W. 2 p.m. Mr. H. V. Routh, "Victorian Poetry."

At Bedford College for Women, Regent's Park, N.W. 2 p.m. Prof. Spencer, "History of Chemistry."

At Bedford College for Women, Regent's Park, N.W. 3 p.m. Prof. Mackie, "The Study of Scottish History."

At King's College, Strand, W.C. 5 p.m. Dr. J. W. Pickering, "Blood Plasma and Platelets." (Lecture II).

At King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1861." (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Rev. P. Dearmer, "Byzantine and Byzantinesque Art." (Lecture II).
At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. Dr R. Thurnwald, "The Problem of Evolution in the Social Processes." (Lecture II).
At St. Thomas's Hospital Medical School, Albert Embankment, S.E. 5 p.m. Dr A. St. G. Huggett, "The Physiology of the Fœtus." (Lecture II).
At University College, Gower Street, W.C. 5.30 p.m. Prof. B. Ashmole, "Aim and Method in the Study of Ancient Art."

WEDNESDAY, OCTOBER 16..Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, "Anatomy—The Essential Features of the Face, Head and Neck."
Microscopical Society, 20, Hanover Square, W. 7.30 p.m.
Public Health, Royal Institute of, 37 Russell Square, W.C. 4 p.m. Dr. E Graham Little, "The Health and Conditions of Work of Medical Students."
University of London, at Birkbeck College, Bream's Buildings, Fetter Lane, E.C. 5.30 p.m. Prof L. L. Schücking, "Puritan Traits in English Civilisation." (Lecture II)
At Bedford College for Women, Regent's Park, N.W. 10 a.m. Miss Coventon, "John Keats."
At Bedford College for Women, Regent's Park, N.W. 4.15 p.m. Miss Ellis-Fermor, "Restoration Drama."
At King's College, Strand, W.C. 5.30 p.m. Prof. Dr. A. Hevesi, "Shakespeare in Hungary."
At King's College, Strand, W.C. 5.30 p.m. Rev Canon C. Jenkins, "The Contribution of King's College to the Advancement of Learning during the Century 1829—1928." (Lecture II).
At King's College, Strand, W.C. 5.30 p.m. Dr. F. A P. Aveling, "Personalism A Psychological Approach to Reality." (Lecture II).
At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. Luigi Einaudi, "Taxation." (Lecture I).
At the London School of Economics, Houghton Street, Aldwych, W.C. 6 p.m. Lecture II on "Office Machinery."
At the London School of Hygiene and Tropical Medicine, 37 Torrington Square, W.C. 6 p.m Prof. Dr. T. J. M. Madsen, "Milk Epidemics."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m Sir E Denison Ross, "Libraries in the Near East."
At University College, Gower Street, W.C. 5.30 p.m. Prof. K. Fajans, "Chemical Forces and Atomic Structure." (Lecture II).
At University College, Gower Street, W.C. 5.30 p.m. Mr. J. H. Helweg, "Copenhagen, Past and Present." (Lecture I).

THURSDAY, OCTOBER 17. Chadwick Public Lecture, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 8.15 p.m. Mr. Arthur J. Martin, "Sewage and Sewage Disposal." (Lecture II).
Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. H. Burton and C. K. Ingold, "The Modes of Addition to Conjugated Unsaturated Systems. Part II: The Reduction of Conjugated Unsaturated Acids by Metals Dissolving in Aqueous Media." (2) Messrs. G. T. Morgan and E. A. Coulson, "Synthesis of Anthracene Homologues. Part I: 2:6- and 2:7-dimethylanthracenes." (3) Mr. A. W. Chapman, "Dynamic Isomerism involving Mobile Hydrocarbon Radicals. Part I: The Triarylbenzenylamidines." (4) Messrs. T. M. Lowry and F. L. Gilbert, "Studies of Valency. Part XIV: An Optically-Active Telluronium Salt; p-tolylphenylmethyltelluronium Iodide." (5) Messrs. T. M. Lowry and F. L. Gilbert, "Studies of Valency. Part XV: Optically-active p-tolylphenyltelluroxide." (6) Messrs. G. T. Morgan and E. A. Coulson, "Synthesis of Anthracene Homologues. Part II: 2:3:6-trimethylanthracene."
Constructive Birth Control and Racial Progress, Society for, Grotrian (Steinway) Hall, Wigmore Street, W. 8.30 p.m. Dr. Marie Stopes, "Birth Control To-day: Some New Methods and Experiences."
University of London, at Birkbeck College, Bream's Buildings, Fetter Lane, E.C. 5.30 p.m. Prof. L. L. Schücking, "Puritan Traits in English Civilisation." (Lecture III).
At Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Eccles, "Montaigne." (Lecture II).
At Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Prof. L. Abercrombie, "The Teaching of Literature."
At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of the Carbohydrates and Fats." (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Dr. Prof. A. Hevesi, "Great Figures of Hungarian Literature." (Lecture II).
At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m Prof. Dr. R. Thurnwald, "The Problem of Evolution in the Social Processes" (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Prof. Neale, "The Elizabethan Parliament." (Lecture I).

FRIDAY, OCTOBER 18. Dyers and Colourists, Society of, Milton Hall, Deansgate, Manchester. 7 p.m. Dr. Tagham, "The Application of the Locust Beans in the Textile Industry and especially in the Calico Printing Trade."
Electrical Development Association, British, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Miss G. Burlton "Personal Salesmanship in the Electrical Industry."
Historical Society, 22 Russell Square, W.C. 5.30 p.m. Prof F. M Stenton, "The Danish Settlement of the Ninth Century and its Results."
Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Mr. W. A. Willox, "Some recent French Railway Construction."
Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Dr. Daniel Adamson, Presidential Address.
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne. 6 p.m. Mr. Launcelot E. Smith, Presidential Address. Annual General Meeting.
Public Health, Royal Institute of, 37, Russell Square, W.C. 5 p.m. Prof Dr. Rudolph A. Peters, "Co-ordinative Bio-Chemistry of the Cell and Tissues. Cell Surfaces with reference to the part played in the Integration of Cell Processes by Adsorption."
University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Dr. A. Hevesi, "Great Figures of Hungarian Literature." (Lecture III).
At King's College, Strand, W.C. 5.30 p.m. Prince D. S Mirsky, "The Russian Drama." (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Mr. A. E. Stamp, "The Authenticity of the Disputed Revels Accounts."
At King's College for Household and Social Science, 61 Campden Hill Road, W. 5 p.m. Prof. H. V. Mottram, "Human Nutrition." (Lecture I).
At the London School of Economics, Houghton Street, Aldwych, W.C. 2.30 p.m. Dr. W. Rose, "German Life and Literature from the End of the Thirty Years' War." (Lecture I).
At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. Luigi Einaudi, "Taxation." (Lecture II).
At the London School of Hygiene and Tropical Medicine, 37 Torrington Square, W.C. 6 p.m. Prof. Dr. T. J. M. Madsen, "Diphtheria Toxin and Antitoxin."
At University College, Gower Street, W.C. 5.30 p.m. Prof. K. Fajans, "Chemical Forces and Atomic Structure." (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Mr. H. J. Cohen, "The Origins of the Legal Profession in England."

SATURDAY, OCTOBER 19..L.C.C. Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. D. Martin Roberts, "London in the Middle Ages."

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THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.*

By A. Lennox Stanton,

M.I.Mech.E., M.I.E.E., M.Amer.S.Mech.E., M.I.E. (India).

Isolated independent enterprise, tending to make electricity supply a communal luxury, is rapidly being displaced by a pioneer process or reorganization for the attainment of pooled or co-ordinated electricity supply systems. These are professedly designed to transmit and distribute energy under conditions of maximum utility within the areas of their application.

Now it is indisputably true that electricity is the most flexible of power agents in existence, and no limitation can be placed on its adaptability to meet the needs of man. Moreover, so rapidly is expansion taking place, correlatively with an ever-increasing demand for electricity as an established element of life, that the question of planning development on lines which permit of energy being delivered to the consumer at the lowest possible rates, has become of primary importance.

This position is largely the outcome of a world-wide recognition that electricity is a particularly potent means by which many limitations prevailing in both industrial and social life may be broken down. Its recognition is self-evident in Great Britain, through the joint labours of the *Electricity Commissioners* and the *Central Electricity Board*, nevertheless, the realisation that the full advantages which follow electrical development cannot come about until *organised* publicity is focussed upon the question of rates, finds a fuller expression on the other side of the Altlantic than is the case here.

An outcome of this activity to which particular attention may be drawn is the ability of electric utilities in America to place more power behind the

*Some notes on the labours of the Hydro-Electric Power Commission of Ontario. Address presented to the *Overhead Lines Association*, March 20th, 1929.—Reprinted from *World Power*, May, 1929.

industrial worker than is the case in other countries. Moreover, an increasing prominence is there given to propaganda claiming cheap power as the panacea for most of the commercial, industrial, and domestic burdens in life. It follows, *cheap* power is looked upon a , a major asset in maintaining the prosperity of the American people, and an increasing activity prevails there, organised to combat any conditions which threaten to limit its availability

Across the Canadian border a similar outlook is held, but in so far as the Province of Ontario is concerned, the system of development adopted differs fundamentally from that found in general operation throughout both the adjoining province of Quebec and in the United States. Ordinarily, the difference is contained within the meaning of all that is connoted by the terms private and public ownership, which means, in electrical undertakings, that not only do the financial objectives and limitations under which development is carried out differ, but also, that the objective relationship holding good between the supplier and the consumer differs too

In the United States private ownership is the rule, and communities with electric service have to rely upon a system of what is termed " public regulation " for the availability, adequacy, and fairness of rates charged

In Ontario public ownership is the rule, but at present, as will be shown late , in its administrative character, and more especially in its relationship to consumers through the medium of rate structure, it has no parallel anywhere in the world The scope of its activities renders all communal development subject to the wide spread powers of a special Power Commission Act, and responsibility for the carrying out of the expressed aims of the Act and for the proper administration of all that is called for the eunder is vested in a body corporate, known officially as *The Hydro Electric Power Commission of Ontario*

It needs but little thought to recognise that the success or failure of such an undertaking has a particular significance for the opponents of public ownership all over the world. To date, and even if judged by nothing more than the evidence of available published matter definitely opposed to what the Commission's constructive activities represent, it cannot be doubted that its labours have played a far greater and wider part than is commonly recognised, in that few, if any, assets of national life possess greater value than a cheap and abundant supply of electricity

Purely commercial comparisons of the relative systems of development invariably ignore this all-important outlook, and by reason of attempts to build up comparative data, more or less favourable to the point of view only of either the investment holder or the large power consumer, rarely fail to present statements indicative of that limitation.

As the major portion of development methods in the United States are directly opposed in principle to those of the Ontario undertaking, it is not surprising to find *that the successful and continued expansion side of the latter undertaking* is referred to most frequently in the United States, by that section

of the public who are desirous of creating a demand there for a similar monopoly of electric power resources.

This has been provocative of highly organised opposition, in which a large amount of literature, inimical to the labours of the Commission, has found a prominent place. Undoubtedly creative of much confusion of issue and objective regarding the Commission's activities, this controversy has probably done more than anything else could have done to enlighten the minds of consumers regarding electrical matters. There now exists a situation in the United States which has in view the probing of the practical value of "public regulation" of rates, through a searching and critical inquiry into the administration of their own utility undertakings.

Now, it is true that the unusual water-power facilities which exist at Niagara make it possible to generate large amounts of electrical energy at that point at an exceptionally low cost, but the *whole* cost of generation is only the beginning of a straight line sequence of *total* cost terminating at a consumer's meter, and in the case considered here, possibly located on a farm more than two hundred miles distant from the point of generation.

Therefore, in considering what follows, it is well to remember that advances made in generating electricity by prime movers other than water have been no less rapid, and where favourable facilities exist for creating high-grade steam-operated plants, that the whole cost of generation may compare sufficiently favourably with the whole cost of hydro-electric generation at particular sites, so as to render any difference in this item of the total cost of delivering energy to consumers' terminals comparatively unimportant, when considering the question of a rate base.

It may be said that the conditions of electrical development applicable to Ontario and Great Britain are too diverse in character, both in conditions of application and in function, to admit of any constructive comparison, but is such a statement correct?

Its truth, or otherwise, can only be ascertained from a consideration of fundamentals, probably related to basic elements in development, which are independent of locality in their effect upon rate bases; and this only when the fundamentals are stripped of complications common to the realms of financial manipulation and accounting.

Where in the world can be found a similar area so richly endowed as Great Britain with the natural resource COAL, together with such wonderful facilities for cheap and rapid transport by land or water? Where can be found a similar area wherein so colossal a waste has been recorded, and wherein so great a confusion of issue is presented, when viewed (as it should be) from the standpoint that coal represents the same asset to this country as water does to Ontario?

Moreover, since limitation of sites, which make the costs of generation vary widely under hydro-electric developments located far apart, do not

apply to large modern steam plants, it is clear that, if the best natural conditions here were properly developed and correlated throughout the whole country, the forced dependence upon steam plants could be turned to positive advantage for the stabilization of rates uniformly conducive to the use of electricity on scales calling for many changes in present methods. Nor, in this connection, is it to be overlooked that the major hydro developments of Ontario are necessarily located far less favourably than are the steam-raising facilities of this country. Witness power now being transmitted to the Niagara system from a point of generation in the Province of Quebec.

THE ORIGIN OF THE HYDRO-ELECTRIC POWER COMMISSION.

Primarily, Canada is an agricultural country, but each year that passes indicates the attainment of proportionately greater industrial importance. Under present conditions, the most intensive areas of development lie within the Provinces of Quebec and Ontario, where the proximity of the United States across a common waterway has had a profound influence upon industrial effort.

Of the two Provinces named, Ontario is well known as the chief manufacturing area of Canada. In addition to this, and its extensive agricultural, dairy, and lumber interests, Ontario produces ninety per cent. of the world's supply of nickel, holds the third world-position for gold production, produces silver and copper on an increasingly extensive scale, and, as a producing Province, accounts for more than one-third of the annual production of Canada. With a population of barely three millions, of whom approximately one-third dwell in what would be termed rural areas in this country, its area exceeds three and a quarter times the square mileage of the entire British Isles.

Perhaps it is well to point out here that the foregoing facts and the preceding introductory remarks are necessary to a proper comprehension of the degree to which the industrial and social life in Ontario is bound up with the advantages derived from the availability of a plentiful and cheap supply of electricity.

As will be shown later, this all-important aspect of the general activity is not wholly attributable to the uses to which natural resources not available elsewhere have been put, but is equally reflective of an ability, on the part of the people themselves, to create conditions whereby natural resources might be developed and utilised in the fullest possible measure for the greatest common advantage.

This ability forms the response to a spirit of common endeavour in the development of conditions designed to place the advantages of electricity within the reach of all living within well-defined areas of economic accessibility: this, moreover, even to the extent of providing for that section of the community which, otherwise labouring under conditions of maximum drudgery

and hardship, is *individually* least able to pay for the full initial cost of its availability.

It is educational to consider how this rare state of affairs has come about.

At the beginning of the present century, it had dawned upon the minds of those gifted with foresight that the Province of Ontario was so blessed with potential resources and possibilities for industrial effort, that every incentive existed for furthering its advantageous development. The greatest apparent obstacles were two-fold: the first was contained within the undesirable dependence of the Province upon extraneous sources for its supplies of fuel; the second, of a mental order, necessitated the awakening of the people to a recognition of the development possible through and by organised effort having a common objective.

As an offset against the serious physical deficiency in fuel resources, there were well-recognised possibilities for developing hydro-electric power, of which the Falls of Niagara formed by far the largest and most attractive proposition. Supplementing this recognition existed a keen spirit of inquiry into the possibilities of electricity, not only as an aid to industrial development, but also as a most valuable adjunct in raising the general standard of life throughout the Province.

The outcome of this public interest was a strong demand for legislation to enable municipalities to take such concerted action as would provide for adequate supplies of electrical energy being available at as low a cost to the consumer as possible. In 1903 the Government of Ontario provided the means for the formation of a Commission to investigate and report upon all questions involving the generation, transmission, and distribution of electricity in the Province.

The report was completed and published in 1906, during which year the Provincial Government, by a special Act, provided for the creation of the Hydro-Electric Power Commission of Ontario. Such in brief was the original material out of which has arisen the extensive undertaking of to-day.

In 1908 the Commission, acting on behalf of the municipal and other interests served, decided to purchase power in bulk, and, building its own transformer stations, distribute the purchased energy. Its initial load was less than one thousand H.P.; in 1915 the Commission had reached the limit of its contract for 100,000 H.P. with the Ontario Power Co., and in 1917 purchased that Company's plant outright, followed in 1920 by the purchase of plant owned by the Toronto Power Co.

Physical Growth of the Undertaking.

Subsequent growth is shown by the figures which follow here, indicating how the distribution of power generated and taken over a twenty-minute-peak period in December, 1927, was allocated over eight distribution systems:

System.	Horse power.
Niagara	853,960
Georgian Bay	21,791
St. Lawrence	9,033
Rideau	3,123
Thunder Bay	42,332
Ottawa	18,794
Central Ontario and Trent	47,994
Nipissing	3,225
Total H.P.	1,000,252
During the fiscal year 1926-27 the total output in KWh. was	3,904,432,004
Adding KWh. purchased, representing	201,802,454
The total undertaking output for year 1927 was	4,106,234,458

Overhead line-work finds a full scope by reason of a phenomenal expansion, under what necessarily included a considerable period of pioneer practice. Apart from power requirements covered by block purchase, the eight systems connect up twenty-two hydro-electric generating plants ranging in normal operating capacity from 428 H P. at Carleton Place to 522,790 H.P. at Queenston, Niagara. Of these eight systems, seven transmit under 60-cycle conditions, while the eighth, Niagara, transmits at 25 cycles

At the end of October, 1927, over 3,350 miles of transmission line alone was in service, operating under eleven line pressures, ranging from 12,000 to 110,000 volts; the greatest length of continuous 110,000-volt line in service forming a stretch of approximately 240 miles. On the 1st of October, 1928, delivery of 25-cycle power to the Commission by the Gatineau Power Co., located in the Province of Quebec, for use on the Niagara system, was inaugurated under a contract which calls for the transmission of an ultimate load of 260,000 H.P. over a distance of 230 miles, at a line pressure of 220,000 volts.

During the year under review, and dealing with energy delivered to municipal areas, advantage was taken of available supply by 433,128 consumers out of a population numbering 1,631,149 The Niagara system supplied approximately 84.8 per cent. of the total consumers under this head, and the distribution of energy over the whole of ten municipal systems was as follows :

(*a*) Twenty-four cities, each having a population of not less than 10,000; about 80 per cent. of the energy distributed was utilised by this group, numbering 324,534 consumers in a population of 1,247,804.

(*b*) Fifty-eight towns, each having a population of between 2,000 and 10,000; about 12 per cent. of the energy distributed was utilised by this group, numbering 67,980 consumers in a population of 267,701.

(*c*) One hundred and twenty small towns, villages, and rural areas, each having less than 2,000 inhabitants. The area served here embraces 35,244

consumers in a scattered population of 115,644, which is augmented by 5,370 consumers resident in 48 Police Villages, making the total number of consumers up to 40,614. At present this group utilises less than 10 per cent. of the energy distributed, but legislative measures designed to secure that supply service should be available for meeting its needs have been given a very definite place in the Commission's activities.

Financial Position.

Turning now to the financial position of the undertaking, it should be noted that all monetary values which follow hereafter have been translated into approximate sterling equivalents, on the basis of 4.866 dollars to the pound sterling and 2 cents to the penny.

The accounting year 1927 (which forms the latest available completed annual return), shows the total investment of the Commission to date, represented by power undertakings, hydro-electric railways, municipalities in distributing systems, and other assets to exceed £58,809,031 In the same year (1927) the total aggregate revenue derived from this capital investment exceeded £6,998,912, and the Commission reported that the revenue obtained from the consumers had been more than sufficient to meet the full cost of generating and transmitting the electrical energy, as well as to provide for all operating expenses and the fixed charges of the municipal utility equipments.

Year by year, too, the reserves of the undertaking have been steadily increasing, both with respect to the collective investments of municipalities in generating stations, transmission station and transmission lines, also with respect to their local investments in distributing systems and other assets. At the end of October, 1927, the aggregate reserves reached £13,447,295.

Respecting the cost to the ultimate consumer of electricity furnished to municipalities by the Commission, an inspection of available data for the year ending October 31, 1927, and subsequently received, reveals the following striking features :

(i) The average annual consumption per *domestic* consumer over the entire Province reached the high figure of 1,242 units, delivered at an average cost of 0.9 pence equivalent per unit.

(ii) The area of *highest* communal density located at the greatest distance from a generating station (a matter of 238 miles) received its supply from the Niagara system. With a population of 56,433, the domestic consumers numbered 13,742, and the average monthly consumption under this service was 189 units, delivered at a net cost of 0.8 pence equivalent. Power service consumers in the area numbered 366, and the average cost per H.P. per year was approx. £5.238 equivalent.

(iii) The area of *lowest* communal density located at the greatest distance from a generating station (a matter of 267 miles) also received its supply from the Niagara system. With a population of less than 2,000

the domestic consumers numbered 177, and the average monthly consumption under this service was 71 units, delivered at a net cost of 1.55 pence equivalent. Power service consumers in the area numbered 6, and the average cost per H.P. per year was approx. £6.935 equivalent.

(iv) The lavish use which is being made of electricity by domestic consumers was shown by the increase of over 16 per cent. in consumption over the previous year, representing an increase in the domestic demand of over 65 million units.

(v) Checks of domestic service data, furnished for a period commencing with the year 1914 and terminating in 1927, show a steady reduction to have taken place in the average cost per kilowatt-hour, but that a point has been reached in the lowest levels now operative, below which it is unlikely they will fall. The high average consumption under this head is attributed chiefly to the policy followed by the undertaking, in providing electricity "at cost," which is supplemented by facilities under rate schedules, designed to encourage a liberal use of the service.

(vi) Indicating the trend of power application and more particularly as relating to domestic consumers, it is interesting to note that more twenty-five ampere, three-wire meters are sold in Ontario than any other size, and that Canadian meter practice limits the smallest size single-phase meter to ten amperes. The extent of the growth in power consuming devices is shown by the following table :

Application.	Estimated Number in Use.		Estimated Installed Capacity in KW.	
	Dec. 1924.	Dec. 1927.	Dec. 1924.	Dec. 1927.
Ranges	47,505	83,298	285,030	499,788
Hot plates	18,883	34,178	37,766	68,356
Washers	55,342	92,219	11,068	18,443
Vac. cleaners	64,205	88,539	12,841	17,707
Water heaters ..	16,665	32,211	25,000	48,316
Air heaters	130,000	131,531	82,400	105,225
Ironers	1,590	2,403	4,770	7,209
Irons	307,800	363,476	203,148	239,894
Refrigerators	657	11,176	130	2,235
Toasters	152,200	171,317	83,710	94,224
		Total ..	745,863 KW.	1,101,397 KW.

(vii) Development in rural areas proves it to be of increasing importance, and the manner in which this difficult class of service is being dealt with bids fair to rank as an outstanding feature of the Commission's activities.

RURAL SERVICE.

Having travelled thus far, now turn to the rural line side of the Commission's labours. At the present time, the Commission is operating 130 rural power districts in different parts of the Province, a typical district covering about 100 square miles, which is governed in respect to area by the economic limitations presented through proximity to suitable distribution centres served from a transmission line.

Recognising that the cost of distributing small quantities of power in rural districts necessitates rates which are considerably higher than the rates in urban centres, where consumers are located more or less close together, the Provincial Government, as far back as 1921 and in fulfilment of its policy of promoting the basic industry of agriculture, decreed an Act to provide aid in the construction of works in rural power districts.

Under the present statutory obligations, wherever the economic conditions are deemed by appointed authorities to justify rural district service, it is enacted that the Provincial Government may pay out to any properly recognised distributing authority "a sum not exceeding fifty per centum of the capital cost of constructing and erecting in the rural power district, primary transmission lines and cables, service transformers and meters and secondary lines on the highway required for the delivery of power in such rural power district."

The experience gained by the Commission to date is such as enables electrical service to be given to rural districts when there can be secured three signed farm contracts, or their equivalent, per mile of line to be constructed.

The rates *first* submitted to the prospective consumers therefore constitute a maximum, and these may be, and in practice frequently have been reduced, as the number of consumers per mile of line constructed in the district increase above the required minimum. Having made its grant-in-aid, the Government's participation in operations respecting the property to which the grant applies ceases.

In their annual rates the rural consumers pay the whole of the cost of power as delivered to the boundary of the rural power district; the whole of the operating and administrative expenses chargeable to the rural power district; the reserves for renewals and contingencies on the whole of the transmission lines and equipment, as well as interest and sinking fund applicable to half the capital investment for the primary and secondary lines and equipment.

As applies to all other public services throughout the undertaking, service given by the Commission is always advised as *at cost*, and rate or tariff schedules are formulated on that basis. Should, however, a greater use be made of the service than was anticipated, a greater revenue will result without proportionate increase in expenses, and therefore a greater surplus will also result. This has been the experience of the Commission in connection with the operation of rural power districts, and during the year under review (1927) the Commission returned approximately £47,266 equivalent in cash to rural consumers, which

amount had been collected in excess of the actual cost of service in the various rural power districts.

The present capital investment in rural lines and equipment now exceeds one and three quarter million pounds equivalent, and the growth of service between the years 1923 and 1927 was as follows:

Year.	Miles of Primary Line.	Number of Consumers.			Power Supplied.
		Hamlet.	Farm.	Total.	
1923	1,058.59	4,158	3,822	7,980	3,514 H.P.
1927	2,921.78	15,526	9,757	25,283	13,273 H.P.

Underlying Principles of the Commission's Activities.

Brief and incomplete as this limited review of the Commission's activities necessarily must be, nevertheless, it should suffice to create an interest in governing principles, conceived of and believed in by its inaugurators, which, originally adopted and subsequently modified to meet the necessities of experience, underlie and consolidate its labours.

Primarily, the declared function of the Commission is one of using its best endeavours to secure an adequate and reliable supply of electrical energy for the people of Ontario at the minimum cost to the consumer consistent with the financial stability of the enterprise. In labouring to attain this difficult objective, while the Commission generates and transmits energy in much the same way as a wholesale manufacturer may who also runs his own selling business, it also acts in the capacity of Trustee for the partnership of municipal authorities co-operatively organised to obtain power at cost, each authority paying its due proportion of the cost for the service rendered. Each authority then sells electrical energy to its own local consumers at rates and under conditions approved by the Commission.

Moreover, the dual responsibility which devolves upon itself as "Supplier" and to the "Consumer" as the source of revenue, under the special relationship here holding good between the financial structure and consumers' rates, is such as not only to provide for meeting all the usual fixed charges included thereunder, but also to provide—

(*a*) For effecting such rate adjustments between the various classes of service as may be found necessary to ensure that, as nearly as is practicable, the service to each class and to each consumer shall be at *cost*.

(*b*) For the people themselves ultimately becoming owners of a fully paid up local undertaking.

The Commission also acts as a purchaser of material for all municipalities desirous of the advantages such a course affords, and otherwise aids consumers through the medium of an extensive publicity organisation. Furthermore, all

electrical equipment it is proposed to connect up on a service must receive the approval of the Commission's inspection department before use; also, all indoor wiring and all completed installation work is subject to a compulsory inspection, this being the rule throughout Ontario.

Conclusion.

In conclusion, special attention is drawn to twelve appendices containing supplementary data deemed to be of interest.

Bearing in mind the defined objects of the Overhead Lines Association, and having particular reference to the one which reads as follows:

> "To assist in making available with reasonable promptness, in every home throughout Great Britain, an abundant supply of electricity, and generally to adopt any course of action that the members may consider beneficial, and particularly by facilitating the erection of overhead lines, which are the only economical means of achieving that object in areas not very densely populated,"

it will be clear that a purely constructive review of the Commission's activities should possess a special interest for its members

This granted, perhaps it is opportune to remind members here that no other pioneer labour finding active expression in this country at the moment *has quite the same objective* as that implied by the foregoing.

As defined, this objective would appear to classify the O.L.A. as a consumers' advocate; nevertheless, I suggest its fulfilment cannot well become a reality until the fundamentals of both cost and rates are thoroughly investigated.

Finally, I have to express my indebtedness to F. A. Gaby, D.Sc., Chief Engineer of the Commission; to various other Staff Officers of the Undertaking and to William C. Noxon, Esq., the Agent-General for Ontario in this country, for permission to draw upon returns, and to make extracts from both communicated and published data relative to the subject.

APPENDIX I.

TABLE I.

Domestic Service Data for all Municipalities.

Year.	Number of Consumers.	Average Monthly Consumption (KWh.).	Average Cost per KWh.	
			Cents	(Pence Equivalent.)
1914	64,866	21.0	5.08	2.54
1920	193,892	44.6	2.56	1.28
1923	286,858	75.7	2.04	1.02
1927	387,573	103.5	1.80	0.90

TABLE II.

Commercial Lighting Service Data for all Municipalities.

Year.	Number of Consumers.	Average Monthly Consumption (KWh.).	Average Cost per KWh.	
			Cents.	(Pence Equivalent.)
1914	15,657	90.8	4.00	2.00
1920	36,496	140.0	2.50	1.25
1923	46,383	195.6	2.46	1.23
1927	64,039	266.7	2.40	1.20

TABLE III.

Street Lighting Service Data for all Municipalities.

Year.	Wattage of Street Lamps in Use.	KWh.	Average Cost per KWh.	
			Cents.	(Pence Equivalent.)
1925	15,100,000	61,910,000	2.28	1.140
1926	15,114,000	61,967,000	2.35	1.175
1927	16,003,305	65,613,550	2.37	1.185

APPENDIX II.

TABLE IV.

Power Service Data for all Municipalities.

Year.	KWh.	Average Cost per KWh.	
		Cents.	(Pence Equivalent.)
1925	160,031,150	1.06	0.53
1926	177,362,002	1.06	0.53
1927	186,247,165	1.00	0.50

TABLE V.

Commercial Power Service Data for all Municipalities *and Private Power Consumers* of the H.E.P.C.

Year.	KWh.	Average Cost per KWh.	
		Cents.	(Pence Equivalent.)
1925	1,634,409,666	0.61	0.305
1926	1,879,029,286	0.60	0.300
1927	1,933,491,298	0.60	0.300

APPENDIX III.

TABLE VI.

Showing the relation between development and rates in the city of Windsor, population 56,433, area of highest communal density located at the greatest distance from a generating station, a distance of 238 miles.

(*a*) *Domestic Service.*

Year.	Number of Consumers.	Average Monthly Consumption. (KWh.).	Net Cost per KWh.	
			Cents.	(Pence Equivalen
1915	2,519	18	4.9	2.45
1916	3,180	21	4.9	2.45
1917	3,882	26	4.5	2.25
1918	4,415	27	4.2	2.10
1919	5,383	31	3.9	1.95
1920	8,700	53	3.2	1.60
1921	9,731	51	3.0	1.50
1922	10,450	68	2.6	1.30
1923	12,021	94	2.2	1.10
1924	11,263	125	1.9	0.95
1925	12,382	159	1.7	0.85
1926	13,464	177	1.7	0.85
1927	13,742	189	1.6	0.80

APPENDIX IV.

TABLE VI (*continued*).

(b) Power Service.

Year.	Number of Consumers.	Average H.P.	Average Cost per H.P.	
			Dollars.	Approximate Sterling Equivalent.
1917	97	807	19.04	£3.913
1918	101	1205	22.88	4.702
1919	136	1609	24.53	5.041
1920	273	5549	28.28	5.812
1921	341	6169	23.78	4.887
1922	321	6958	30.96	6.362
1923	311	7342	33.53	6.891
1924	335	8015	36.09	7.417
1925	350	7988	34.55	7.101
1926	351	8405	32.13	6.603
1927	366	8477	25.49	5.238

APPENDIX V.

TABLE VII.

Further examples showing the relation between development and rates in municipal areas *not* served from the Niagara system.

1. The city of Ottawa, population 118,697, distance from generating station, one mile.

(a) Domestic Service.

Year.	Number of Consumers.	Average Monthly Consumption (KWh.).	Net Cost per KWh.	
			Cents.	(Pence Equivalent.)
1914	6,342	19	5.0	2.50
1915	7,338	22	3.8	1.90
1916	7,912	23	3.4	1.70
1917	8,636	24	3.4	1.70
1918	9,047	31	2.3	1.15
1919	8,976	45	2.0	1.00
1920	9,451	53	1.8	0.90
1921	9,955	67	1.6	0.80
1922	10,493	93	1.4	0.70
1923	11,050	122	1.1	0.55
1924	11,022	139	1.1	0.55
1925	11,155	151	1.1	0.55
1926	11,217	179	1.0	0.50
1927	11,365	205	0.9	0.45

APPENDIX VI.

TABLE VII (*continued*).

(b) Power Service.

Year.	Number of Consumers.	Average H.P.	Average Cost per H.P.	
			Dollars.	Approximate Sterling Equivalent.
1917	204	3553	17.72	£3.642
1918	207	4743	13.63	2.801
1919	205	4401	14.37	2.953
1920	210	4531	13.61	2.797
1921	228	4910	12.90	2.651
1922	229	5135	13.00	2.672
1923	240	5410	14.52	2.984
1924	243	5762	13.72	2.820
1925	207	5703	14.40	2.960
1926	200	5747	14.38	2.956
1927	200	6105	14.63	3.007

APPENDIX VII.

TABLE VII (*continued*).

2. The city of Owen Sound, population 12,339, distance from generating station, 32 miles. System, Georgian Bay.

(a) Domestic Service.

Year.	Number of Consumers.	Average Monthly Consumption (KWh.).	Net Cost per KWh.	
			Cents.	(Pence Equivalent.)
1918	1,492	17	5.1	2.55
1921	2,075	28	3.8	1.90
1924	2,548	53	2.1	1.05
1927	2,846	68	1.8	0.90

(b) Power Service.

Year.	Number of Consumers.	Average H.P.	Average Cost per H.P.	
			Dollars.	Approximate Sterling Equivalent.
1918	84	1177	27.25	£5.600
1921	109	1403	20.75	4.264
1924	108	1385	21.41	4.400
1927	110	1632	16.82	3.456

APPENDIX VIII.

TABLE IX.

Under *power service* (see *Twentieth Annual Report*) illustrates variations in the average cost per H.P. on selected areas of the Niagara system ; also the *maximum* costs applicable to this service on some other systems of the undertaking.

System Number.	Locality.	Distance from Generating Station (Miles).	Total Consumers.	Power Consumers only.	Average H.P.	Average cost per H.P. Dollars.	Approx. Sterling equivalent.
1	Niagara Falls	1	4,824	83	3,546	21.96	£4.513
1	Chippawa	4	290	5	101	57.61	11.840
1	St. Catherines	18	6,038	125	4,688	15.88	3.264
1	Guelph ..	75	5,488	118	5,725	18.47	3.795
1	Brampton ..	78	1,552	53	813	18.71	3.845
1	Ayr	84	226	4	44	22.65	4.655
1	London ..	123	18,773	495	18,278	20.87	4.290
1	St. Marys ..	133	1,217	42	883	25.21	181
1	Ailsa Craig ..	148	165	2	48	36.48	497
1	Chatham ..	193	4,517	116	2,991	24.98	134
1	Sarnia ..	205	4,591	77	3,510	34.85	162
1	Windsor ..	238	16,070	366	8,477	25.49	5.238
1	Alvinston ..	267	207	4	62	44.01	9.044
2	Arthur ..	63	223	4	51	44.30	9.104
3	Lancaster ..	25	104	1	3	57.94	11.907
4	Kemptville ..	62	349	6	113	40.80	8.384
5	Port Arthur ..	73	4,598	85	34,478	20.52	4.217
7	Bloomfield ..	29	166	9	104	35.24	7.242

For system reference note as follows :—
No. 1 Niagara. 2. Georgian Bay. 3. St. Lawrence. 4. Rideau.
5. Thunder Bay. 7. Central Ontario.

NOTES ON BOOKS.

THE BRITISH EMPIRE SINCE 1783. By A. P. Newton and J. Ewing. London: Methuen and Co., Ltd. 5s.

This is a very useful little book. The British Empire, like all things that are immense—like sky-scrapers and the number one million—is hard for the ordinary person to understand. Besides, the Empire is not a simple, vast mass, like Russia and Siberia, but a number of different countries with varying constitutions and habits. To most Londoners the Highlands of Scotland seem remote ; how much more remote the Highlands of New Zealand or the west of Canada.

It needs more than the familiar kind of patriotism to make us feel warmly about the Empire, and it is not as if the Dominions " belonged " to us, thus allowing us

to enjoy any sense of possession, however diluted. Pride in the Empire is conditional on a more complex sense of values than pride in the busbies of the Guards.

In the first place, it is true that the Empire was made by men from our small home islands who faced and overcame the most alarming perils in their determination to plant the flag firmly in the four quarters of the globe. But apart from the personal qualities that it demands, the business of building empires is not always more respectable than the business of founding great families; in the case of our own Empire, we can be thankful that the lesson of the years round about 1780 was not forgotten, and that since then British Imperial policy has increasingly shown respect for Reason.

Politically, economically and culturally, the Empire ought to have a future more thrilling even than its past. The part the imperial race has the chance of playing in the diffusion of western civilisation is an important one indeed. Cut off from the European mother country, the Dominions would have a far harder task to carry on the humanistic traditions of the Old World, than if linked with her by ties of sound sentiment and intelligent economics. Man does not live by bread alone, nor new countries by their physical resources.

But we cannot study the future. We can study its roots in the past and present, and a good means of our doing so, where the Empire is concerned, is the text-book offered to us by Messrs. Methuen. The facts are presented without varnish, which is good. Statistics have a glamour of their own, and perhaps a more civilised appeal than the recital of daring deeds.

Great Britain is overcrowded, but the Empire is underpopulated. The problem of emigration can never be given up till it is solved. Must we, in peace as in war, waste our human resources?

Here are some of the facts and figures. Let us hope that before long someone will come forward with the Ideas.

PRACTICAL STEEL MAKING. By Walter Lister. London: Chapman and Hall, Ltd. 25*s.*

The author of this book states in his preface that he has been for many years impressed by the lack of literature and information of practical value available for the man who is going to work the furnace. After all, as he says, he is the main factor contributing to the success or otherwise of any modern steel works undertaking. Without his intelligent co-operation the best of theoretical intentions go astray. Accordingly he has written this book in a simple and concise form, giving the results of over twenty years' experience of practical steel making in most of its various branches and methods. He has not gone fully into such aspects of the subject as details of construction, lay-out of plant, costs, etc. This has been done many times already. He has dealt simply with the essential aspects that come under the direct control of the steel maker. It is not to be expected that all his views will be accepted: some of them will no doubt be criticised; but it must be remembered that the book is the first of its kind, and that it is very much needed.

It deals mainly with the acid and basic open-hearth process, and this is as it should be, because by far the greater part of the steel which is manufactured at the present time is made by one or other of these processes. We are glad to notice, however, that electrical steel making is adequately considered and discussed. There is a very good chapter on special and alloy steels. Attention may also be directed to the chapter entitled "Pit Work," which is an excellent summary of this important part of melting-shop practice.

In comparing the acid and basic processes, the author states that the acid process is essentially a means of producing the very highest qualities of steel, and where

quality is the main consideration the prices obtained are correspondingly high. It follows, therefore, that more time is allowed to the man working acid charges in order that the material shall reach the necessary standard and successfully pass all the severe and stringent tests required of it. In the basic process conditions are different. The materials used are less than half the price of those used in the acid process. In spite of this it supplies material of sufficiently good quality for a variety of purposes and its cheapness and rapidity of output renders it available in large quantities for general constructional work. The author insists that the most important point of superiority of acid steel is its ductility and resistance to shock and that the reason for this is entirely the nature of the slag. He writes: "The composition of the slag of an acid charge almost prohibits the existence of any dissolved oxide of iron in the steel and this is the whole secret of its superiority. . . . From the commencement of the working of the charge, any free oxide of iron contained in the bath is immediately attacked by the silica of the hearth forming a silicate which makes its way into the slag. When iron ore is fed, any surplus oxide of iron not reduced by the carbon of the charge or taken up by the silicon of the pig, is immediately taken up by the silica of the hearth, and this can always be noticed in the cutting action of a thin slag which is always a slag containing an excess of oxide of iron In the basic process this is not so, all the available silica being taken up by the lime of the slag, leaving none to combine with any free oxide of iron, so that all the deoxidising has been done by the addition of siliceous materials or other deoxidisers either to the bath or to the ladle, which at the best are never so completely successful as the natural conditions and reactions pertaining to the acid open-hearth."

This difference between acid and basic steel is most marked in bath samples. In the former the skin of a sample is always beautifully bright and glossy, the sample thus being absolutely solid and free from blow-holes and the grain of the steel fine and dense In the latter the skin of a basic sample of the same analytical composition is dull and lustreless. The sample is pitted with blow-holes and the grain is coarse and open. The author points out the significant fact that it is much more easy to obtain low carbon in the basic (below 0.10 per cent.) than it is in the acid process. It is the exception rather than the rule to obtain carbon below 0.15 per cent. in the latter process. This again points to the absence of free or dissolved oxide of iron in the acid after feeding has ceased, whereas it is always present in the basic even after all feeding has ceased for some time.

Under the heading "Neutral Steel" a process is described whose object is to obtain the good qualities of acid steel in a basic-lined furnace. It consists of first charging a layer of good clean scrap on the furnace bottom and then the whole of the pig iron which is hematite and may constitute about 50 per cent. of the charge. When this is melted the remainder of the scrap is charged into it in small portions at intervals until the charge is complete and the whole melted up. The high silicon content of the hematite pig keeps the bath to a large extent free from oxide of iron during melting, and care is taken to avoid any further additions of oxide as much as possible, more scrap being used if necessary to reduce the carbon content of the bath.

The book is well printed and adequately illustrated. It is to be hoped that it will be carefully studied by those for whom it is intended. Considering what it gives, it cannot be regarded as expensive at 25s. All the same, this price will keep it out of the reach of many into whose hands it should fall. If it were possible to issue a cheaper edition, this would undoubtedly be a great boon to the men engaged in the industry.

THE STYLES OF ENGLISH ARCHITECTURE Part II. By A. Stratton, F.R.I.B.A. London: B. T. Batsford, Ltd. Paper, 1*s* 6*d.*; Cloth, 2*s* 6*d*

This is the second of Mr. Stratton's Introductory Handbooks. The first brought us down to the end of the 15th century, and this one takes us to the end of the 18th. The Handbooks are companions to a series of large scale comparative diagrams (30 × 20 inches) intended for students and teachers.

These diagrams are reproduced on a small scale in the Handbooks, and the illustrations leave us no doubt as to their utility and excellence. Each one consists of a plan, an elevation or interior, and details of stone or woodwork. Every stage in the evolution of English architecture is represented.

The short descriptive text is very much to the point. Enough is said about history to account for the main developments before Inigo Jones, from whose time the personality of great architects counts for as much as the more impersonal elements of time and change.

Mr Stratton really provides the kind of summary that is so welcome to those who have been working laboriously, and have at last begun to suffer from a mental indigestion. Salient facts are a fine aperient; they are perhaps less valuable as a complete food for the ignorant. When students have reached the end of their fat text book let them turn to Mr. Stratton.

ARCHITECTURE AS A CAREER. By P. A. Robson, F.R.I.B.A. London: B. T. Batsford, Ltd. 5s.

This "manual for aspirants and students of either sex" ought to be about in the junior common rooms of our universities, so as to fall into the hands of undergraduates at what is a very critical period of their careers. The young man and maiden with humanistic inclinations generally feel despairingly that only in the overcrowded literary world might they solve their problems of subsistence and self-realisation.

Architecture appeals to them, but as a profession it seems only a remotely possible choice. Now there are difficulties here as elsewhere, and competition is keen here, too, but once these difficulties are clearly understood they appear less insuperable than before.

Mr. Robson's plain-spoken little book will quickly show the aspirant how he or she stands; what examinations have to be passed and what studies these examinations involve. Those who can afford the cost of living without earning for the requisite time, will not find the fees asked by the schools and the R.I.B.A. exorbitant.

It is after all possible that we are on the eve of a great modern movement in building, and that exceptional opportunities are awaiting students who will be starting to practice in four or five years. P.B.

GENERAL NOTE.

BRITISH INSTITUTE OF INDUSTRIAL ART.—The British Institute of Industrial Art will hold its Autumn Exhibition in the North Court of the Victoria and Albert Museum, S.W. 7, from the 9th November to the 18th December (Admission free). The main part of the Exhibition will consist of examples of British Industrial Art for the slender purse, including Furniture, Pottery, Textiles, Metalwork and products of the Building Crafts and the Book and Printing Trades. The Exhibition will also include the Institute's Permanent Collection of recent work by British artists, craftsmen and manufacturers; and a section illustrating certain modern tendencies in European Industrial Art.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 21. East India Association, at Caxton Hall, Westminster, S.W. 4.30 p.m. Mr S. K. Ratcliffe, "America and India."

University of London, at Bedford College for Women Regents Park, N.W. 4.30 p.m. Prof Geyl, "The Revolt of the Netherlands." (Lecture II)

At King's College, Strand, W.C. 5.30 p.m. Dr Prof A. Hevesi, "Great Figures of Hungarian Literature" (Lecture IV)

At King's College, Strand, W.C. 5.30 p.m. Rev G. E. Newsom, "The Church and the World Lecture III. Medieval Catholicism"

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Brocklehurst, "Secretion of the Digestive Juices" (Lecture II)

At University College, Gower Street, W.C. 5.30 p.m. Prof. J. Macmurray, "The Philosophical Approach to Modern Social Problems" (Lecture I).

At University College, Gower Street, W.C. 5.30 p.m. Mr. Arthur Stratton, "England in Shakespeare's Day Lecture I Houses in Tudor Times"

TUESDAY, OCTOBER 22. Advertising, Institute of Incorporated Practitioners in, at the Royal Society of Arts, Adelphi, W.C. 7.15 p.m.

Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof Arthur Thomson, "Anatomy The Essential Features of the Face, Head and Neck"

Historical Society, at Stroud Green School, Finsbury Park, N. 6.30 p.m. Dr G. P. Gooch, "The Outlook of Europe"

University of London, at King's College, Strand, W.C. 5 p.m. Dr J. W. Pickering, "Blood Plasma and Platelets" (Lecture III)

At King's College, Strand, W.C. 5.30 p.m. Rev P. Dearmer, "Byzantine and Byzantinesque Art Lecture III—Sculpture, Bridging the Dark Ages"

At King's College, Strand, W.C. 5.30 p.m. Prof Sir B. Pares, "Russian History to 1801. Lecture II Kiev and the Water Road"

King's College (at 40 Torrington Square, W.C.) 5.30 p.m. Dr Julian Krzyzanowski, "The Polish Novel in the 19th Century. Lecture I Henry Sienkiewicz and his Early Novels"

At St. Thomas's Hospital Medical School, Albert Embankment, S.E. 5 p.m. Dr. A. St G. Huggett, "The Physiology of the Fœtus" (Lecture III)

Zoological Society, Regents Park, N.W. 5.30 p.m. Meeting for Scientific Business

WEDNESDAY, OCTOBER 23. Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, "Anatomy The Lower Limb Its Connection with the Trunk The Surface Forms dependent on Bone and Muscle in Action and Repose."

Automobile Engineers, Institution of, at the Engineers' Club, Manchester 7 p.m. Prof. W. Morgan, Presidential Address, "The Member and the Institution."

Public Health, Royal Institute of, 37 Russell Square, W.C. 4 p.m. Mr. J. C. Stobart, "Broadcasting and Health"

United Service Institution, Whitehall, S.W. 3 p.m. Major Walter Elliott, M.P., "Co-ordination of Imperial Defence."

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. F. A. P. Aveling, "Personalism: A Psychological Approach to Reality. Lecture III The World of Empirical Experience."

At King's College, Strand, W.C. 5.30 p.m. Mr. A. F. Meyendorff, "The Influence of Capitalism on Communism in Russia." (Lecture I).

At King's College, Strand, W.C. 5.30 p.m. Prof. A. W. Reed, "The Contribution of King's College to the Advancement of Learning during the Century 1829-1928. Lecture III—Language and Literature."

At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture III "Office Machinery."

At University College, Gower Street, W.C. 5.30 p.m. Mr. J. H. Helweg, "Copenhagen, Past and Present." (Lecture II).

THURSDAY, OCTOBER 24. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Captain N. Macmillan, "The Art of Flying Land and Sea Machines."

Asiatic Society, 74 Grosvenor Street, W. 4.45 p.m. Mr. K. A. C. Creswell, "The Aqsa Mosque and the Church of Justinian."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Colonel Sir T. F. Purves, Presidential Address.

Fuel, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 11 a.m. Sir David Milne-Watson, Presidential Address. Papers on "Pulverised Fuel for Marine-Type Boilers," by Mr. C. J. Jefferson, Admiral W. M. Whayman, Mr Harold E. Yarrow, and Dr. G. E. K. Blythe.

Imperial Institute Cinema, South Kensington, S.W. 2.15 p.m. Colonel V. A. Haddick, "Ireland's Rough-Hewn Destiny"

Rubber Technologists, Institution of, at the Manchester Cafe Ltd., Exchange Buildings, Manchester. 7 p.m. Mr F. Walker, "Application of Electricity in the Rubber Industry." Annual General Meeting.

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof Eccles, "Montaigne." (Lecture III).

At Bedford College for Women, Regent's Park, N.W. 5.15 p.m. Mr J. M. Keynes, "The Advisability of Methods other than High Wages as a Means of Improving the Conditions of the Working Class"

At King's College, Strand, W.C. 5 p.m. Dr J. A. Hewitt, "Metabolism of the Carbohydrates and Fats" (Lect. II)

At King's College, Strand, W.C. 5.30 p.m. Mr H. W. Stee[illegible], "The Minorities Question and the Union of Europe Lecture II Minorities Before and After the War"

At University College, Gower Street, W.C. 5.30 p.m. Prof J. E. N[illegible], "The Elizabethan Parliament" (Lecture II)

FRIDAY, OCTOBER 25. Chemical Engineers, Institution of, at the Institution of Civil Engineers, Great George Street, S.W. 6.30 p.m. Dr. W. H. Hatfield, "The Fabrication of Acid-Resisting Steel Plant"

Fuel, Institute of, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 10.15 a.m. (1) Mr. J. S. Atkinson, "The Installation and Operation of Gas Producer Plants for Industrial Furnaces" (2) Mr E. C. Evans, "The Economics of Coke-Oven Gas Utilisation in Industry." 2.30 p.m. (1) Mr E. H. Lewis, "Heat Insulation" (2) Messrs A. J. Dale and A. T. Green, "Fuel Control in the Ceramic Industry" (3) Messrs A. J. Dale and A. T. Green, "Retractories in Application to the Fuel Industries"

Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Mr. Harold Bruff, "Electric Welding as Applied to Bridges and other Structures on the L. & N.E. Railway."

Mechanical Engineers, Institution of, Storey's Gate S.W. 7 p.m. Mr. T. C. Dewhurst, "The Requirements of Overseas Locomotive Engineers in respect of Locomotive Design and Details."

North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, 6.30 p.m. Annual General Meeting.

Physical Society, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W. 5 p.m. 1. Mr. F. C. Connelly, "Some Additional Lines in the Secondary Spectrum of Hydrogen." 2. Dr. E. G. Richardson and Mr E. Tyler, "The Transverse Velocity Gradient Near the Mouths of Pipes in which an Alternating or Continuous Flow of Air is Established." 3. Mr. B. K. Johnson, "Resolving-Power Tests on Microscope Objectives Used with Ultra-Violet Radiation."

Public Health, Royal Institute of, 37 Russell Square, W.C. 5 p.m. Prof Dr R. A. Peters, "The Ministers of Metabolic Change. Experimental Researches upon the Nature and Distribution of the Water Soluble Vitamins."

University of London, at King's College, Strand, W.C. 5.30 p.m. H.E. The Greek Minister, "Byron and Greece."

At King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture II Griboyedov; Shchepkin and Realism on the Stage."

At King's College, Strand, W.C. 5.30 p.m. Prof. D. Saurat, "The French Novel. Lecture I- Pierre Hamp et le roman du travail."

At King's College for Household and Social Science, 61 Campden Hill Road, W. 5 p.m. Prof. V. H. Mottram, "Human Nutrition." (Lecture II).

At University College, Gower Street, W.C. 5.30 p.m. Mr. C. S. Elton, "The Future of Animal Ecology." (Lecture I).

SATURDAY, OCTOBER 26. L.C.C., Horniman Museum, Forest Hill, S.E. 3.30 p.m. Dr. C. Ainsworth Mitchell, "Faces and Finger Prints."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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FRIDAY, OCTOBER 25th, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2.)

NOTICE.

OPENING OF THE 176TH SESSION.

The Opening Meeting of the 176th Session will be held at 8.30 p.m. on Wednesday, November 6th, when the Inaugural Address will be delivered by MR. LLEWELYN B. ATKINSON, M.I.E.E., Assoc. M.Inst.C.E., Chairman of the Council. The subject will be "Fifty Years of Electrical Science and Industry."

After the delivery of the Address, the Society's silver medals awarded for papers read last session will be presented.

Tea and coffee will be served in the Library at the end of the proceedings

ROYAL SOCIETY OF ARTS.

REPORT ON THE SOCIETY'S EXAMINATIONS, 1929.

THE EXAMINATIONS COMMITTEE

Last year the entries for all the Examinations held by the Society for the first time reached a total of over 100,000. In view of their growing importance, the Council thought it advisable to reconstruct the Committee which is charged with the conduct of the Examinations. It is a body consisting at present of thirty-seven members, of whom seven are nominated by the Council, two by Central Education Authorities, thirteen by Local Education Authorities, one each by the Association of Education Committees, the Association of Directors and Secretaries for Education, and the Association of Technical Institutions, five by Teachers' Associations, six by Commercial and Professional Bodies, and one co-opted Member The Committee are at liberty to co-opt nine more members, as and when occasion may arise. It is now a powerful body, thoroughly representative of educational and commercial interests, and may be trusted to see that the examinations are kept on practical lines and calculated to meet the real needs of the class of students for whom they are intended

EVENING COMMERCIAL EXAMINATIONS.

The increase in the number of papers worked at all the Society's Examinations which, as will be seen from the diagram on page 1146, has been steadily and rapidly increasing since 1917, has been maintained this year, the total being 100,696.

The Evening Commercial Examinations were held at three periods, March, May and July. In March the number of entries was 26,318, in May 45,285, and in July 18,570. The entries were divided among the three Stages as follows:

	March.	May	July	Total
Advanced Stage	2,292	7,833		10,125
Intermediate Stage	8,027	17,820	6,561	32,408
Elementary Stage	15,999	19,632	12,009	47,640

The number of papers worked in the written examinations was 85,907, and in addition 586 candidates presented themselves for the *viva voce* Examinations in Modern Languages.

The subjects of Examination this year were:

- Arithmetic
- English.
- Book-keeping
- Shorthand
- Typewriting.
- Economic Geography
- Economic and Social History
- Economic Theory.
- Précis-writing.
- Commercial Law.
- Company Law
- Accounting.
- Banking.
- Costing.
- Foreign Exchange
- Commerce
- Railway Law and Practice
- Railway Economics.
- Shipping Law and Practice
- Law and Practice of Marine Insurance
- Stock Exchange Law and Practice
- Advertising and Salesmanship
- French.
- German
- Italian
- Spanish
- Russian
- Portuguese
- Swedish

Arithmetic.—The total number of entires was 11,623 In Stage III there were 420 candidates, of whom 21 obtained first-class certificates, 241 obtained second-class certificates, and 163 failed. A few very excellent papers were worked, but a large number of those who failed were far below the standard required in this Stage. Some of the worst faults are pointed out in the Examiner's solutions, which are printed in the pamphlet containing the examination questions.

In Stage II there were 2,772 candidates, of whom 473 obtained first-class certificates, 1,007 obtained second-class certificates, and 1,202 failed. The Examiner again comments on the tendency of candidates to give the results only without clearly showing how these are obtained. It is the working as much as the results that the Examiner wishes to see, and the one should be set out as clearly as the other. In many cases the whole subject of percentages in its various applications, had not been mastered.

In Stage I of 8,431 candidates, 1,060 passed with credit, 4,851 passed, and 2,520 failed. The mental arithmetic was generally well done, though weakness was shown in the decimalisation of money In this Stage again, the Examiner complains that the working too often is not properly shown, and candidates should be impressed with the necessity of bearing this point in mind

English. The total number of candidates was 7,274 In Stage III there were 425, of whom 21 obtained first-class certificates, 241 obtained second class certificates, and 163 failed While a certain number of candidates wrote excellent answers to the questions on literature, many of these were brief and inadequate Evidently a large number had not spent sufficient time in studying the prescribed books, and some did not seem to understand what they had read, or were unable to express what they knew In a good many cases the handwriting was difficult to read - a fault which is bound to tell against a candidate

In Stage II of 2,056 candidates, 246 obtained first-class certificates, 1,228 obtained second-class certificates, and 582 failed The essays, for the most part, reached a high standard, and the prescribed books had, as a rule, been read with interest A good many candidates lost marks by failing to observe the instructions given on the examination papers

In Stage I of 4,793 candidates, 94 passed with credit, 2,836 passed, and 1,863 failed.

Book-keeping.—The number of papers worked in this subject reached the very large figure of 24,289, as increase of 427 over the total for 1928 In Stage III there were 3,689 candidates, of whom 398 obtained first-class certificates, 1,540 obtained second-class certificates, and 1,751 failed

In Stage II of 8,553 candidates, 1,278 obtained first-class certificates, 4,810 obtained second-class certificates, and 2,465 failed The exercises, as a rule, were well worked but any item at all out of the way was apt to get candidates into difficulties.

In Stage I there were 12,047 candidates, of whom 963 passed with credit, 7,202 passed, and 3,882 failed. After commenting on a number of the commoner blunders and the reasons for them, the Examiner writes "it is obvious that there are still some centres where candidates do not receive any instruction in the preparation of a Profit and Loss Account and Balance Sheet"

Shorthand.—The total number of candidates this year was 18,558, an increase of 897 over last year's total, when the number of papers sent in was 17,661.

In Stage III there were 1,628 candidates, of whom 225 passed at 140 words per minute, 622 passed at 120 words per minute, and 781 failed The Examiner reports that many of the transcripts, as well as shorthand notes, were excellent, and that the spelling in this Stage showed improvement

In Stage II there were 8,809 candidates, of whom 1,827 passed at 100 words per minute, 3,081 passed at 80 words per minute, and 3,901 failed. The work in this Stage varied a good deal. Many of the transcripts were exceedingly good, but some were very much the reverse.

In Stage I there were 8,121 candidates, of whom 2,675 passed at 60 words per minute, 2,287 passed at 50 words per minute, while 3,159 failed. The percentage of failures is higher than last year, and the Examiner remarks upon the large number of blunders, which are due quite as much to the candidates' disregard

of the sense of the context, as to their inability to decipher their shorthand characters, which were often badly or incorrectly formed. Teachers should make their pupils understand that they must not write nonsense. It is far better to stick to the old adage—" When in doubt, leave it out."

Typewriting.—The total number of entries in this subject shows an increase of 575 as compared with that of 1928, the figures being 10,398 and 9,823. In Stage III there were 1,105 candidates, of whom 339 obtained first-class certificates, 660 obtained second-class certificates, and 106 failed. In Stage II of 3,097 candidates, 1,280 obtained first-class certificates, 1,044 obtained second-class certificates, and 773 failed. In Stage I of 5,296 candidates, 1,279 passed with credit, 3,300 passed, and 717 failed.

In all stages the standard of work submitted was generally satisfactory, with the exception of the time tests and the answers to the questions. In the time tests many candidates were so anxious to attain high speeds that they sacrificed everything to this end. Accuracy is obviously the first essential. In answering the questions a good many candidates must have set down the first words that came into their heads without the slightest regard to common sense, *e.g.*, one wrote " Record ribbons are not used for making carbon copies, but are employed in cutting stencils." Another : " The operator should sit on the machine," and a third " Thirty fingers should be used for striking the character keys and the thumbs for the shift keys." The mentality of the candidates who can produce answers like these leaves one wondering

Economic Geography.—The total number of candidates was 1,048. In Stage III there were 62, of whom 6 obtained first-class certificates, 37 obtained second-class certificates, and 19 failed The good papers were very, very good, but the bad were very, very bad. As a rule, the maps were excellent, although in too many cases the descriptions showed that the candidates could not " read " them.

In Stage II of 204 candidates, 29 obtained first-class certificates, 98 obtained second-class certificates, and 77 failed. Here again, the best papers were admirable, especially those worked in March and May, which the Examiner characterises as the best set of Intermediate papers that he has ever had Three improvements which were noted last year have not only been continued, but emphasised—the sound use of sketch maps, less irrelevancy, and clear efforts to analyse and explain.

In Stage I of 782 candidates, 20 obtained first-class certificates, 448 obtained second-class certificates, and 314 failed. A large number of the failures was due to very marked weakness in answering the two compulsory questions and to the fact that many candidates had only studied portions of the prescribed areas, revealing almost incredible ignorance of the remaining portions. The Examiner writes : " It is lamentable that any preparation for such an examination should not begin with an honest survey of the whole area. In the absence of such a survey it is obvious why so many candidates have seemed to misunderstand some of the simplest geographical phenomena of our islands."

Economic and Social History.—The total number of candidates was 253. In Stage III there were 23 candidates, of whom 8 obtained first-class certificates, 11 obtained second-class certificates, and 4 failed. Though the numbers were small the papers were good, being full of accurate knowledge and lucidly expressed.

In Stage II of 75 candidates, 11 obtained first-class certificates, 35 obtained second-class certificates, and 29 failed. In the May examination the quality of

much of the work was meritorious, and there was only a single failure. The average standard in the July examination was, however, disappointingly low

In Stage I of 155 candidates, 25 passed with credit, 109 passed, and 21 failed On the whole the work submitted was of fair to mediocre quality

Economic Theory.—There were 567 entries in this subject In Stage III of 191 candidates, 17 obtained first-class certificates, 116 obtained second-class certificates, and 58 failed. A good proportion of the papers showed a solid, intelligent and satisfactory knowledge of the subject, which was evidently the result of careful and interested study, but many candidates should have entered for Stage II rather than for Stage III

In Stage II of 376 candidates, 58 obtained first-class certificates 245 obtained second-class certificates, and 73 failed A good general level was reached; most of the candidates had grasped the elements of the subject and were able to present them intelligently

Précis-writing. A good deal is to be said for this subject as a means of training in judgment, accurate thinking, and clear and concise expression It does not, however, attract many candidates, the total number of entries this year being 151, which is only a slight increase on last year's figure, 132 In Stage III of 36 candidates 2 obtained first-class certificates, 23 obtained second class certificates, and 11 failed The passage set called for much judgment in selecting the really important and rejecting the not important. While the best candidates showed not only discretion in selection of facts and skill in arranging them, the worst did very poor work indeed.

In Stage II of 115 candidates, 17 obtained first-class certificates, 53 obtained second-class certificates, and 45 failed The work on the whole was up to the usual level, and the best papers were quite good

Commercial Law In Stage III there were 160 candidates of whom 67 obtained first-class certificates, 84 obtained second-class certificates, and only 9 failed. The papers worked were generally good, in particular, those submitted at the March examination were excellent, they were characterised by accuracy and intelligence, and there were no failures.

In Stage II, of 359 candidates, 199 obtained first-class certificates, 130 obtained second-class certificates, and 30 failed Here again the Examiner reports that the papers, as a whole, were very satisfactory, most of the candidates showing an intelligent knowledge of the principles of mercantile law and their application

Company Law.—In Stage III there were 91 candidates, of whom 28 obtained first-class certificates, 41 obtained second-class certificates, and 22 failed The average standard was fairly high, though in the papers worked in March there was in many cases a lack of knowledge of the principles of Company Law, and even of common sense. The Examiner has, unfortunately, to complain of a good deal of illegible writing. If candidates only realised how much they handicap themselves in this way, surely they would take some care to mend their faults

In Stage II of 217 candidates, 97 obtained first-class certificates, 94 obtained second-class certificates, and 26 failed. Candidates on the whole, showed a very sound knowledge of the principles of commercial law, though here again so many scripts were marred by bad writing that the Examiner finds it necessary to state: "Many candidates forgot that the Examiner can only read answers that are legibly written."

Accounting. 480 candidates entered for this subject, of whom 28 obtained first-class certificates, 240 obtained second-class certificates, and 212 failed. On the whole the papers worked were creditable, and some were very good A good many candidates evidently possessed no knowledge of executorship accounts, although this is prescribed in the syllabus

Banking. – Only 15 candidates presented themselves of whom 2 obtained first-class certificates, 9 obtained second-class certificates, and 4 failed There were no papers of outstanding merit

Costing - There were 93 candidates in this subject, of whom 5 obtained first-class certificates, 46 obtained second-class certificates, and 42 failed A good many confused cost and selling price, while some included profit as an item of cost, and others allowed the costs of one period to be affected by balances of over or under absorbed on-costs of previous periods

Foreign Exchange - The total number of entries in this subject (26) continues to be small, though it shows an increase of 9 over that of 1928 In Stage III there were 14 candidates, of whom 9 obtained first-class certificates and 5 obtained second class certificates The papers were worked in a most encouraging manner, the proportion of first-classes was very high, and there were no failures

In Stage II, of 12 candidates, 6 obtained first-class certificates, 5 obtained second-class certificates, and one failed Here, again, the work submitted was decidedly good

Commerce There has been a distinct increase in the number of entries in this subject, the total this year being 2,872 as compared with 2,492 in 1928 In Stage III there were 331 candidates, of whom 9 obtained first class certificates, 185 obtained second class certificates, and 137 failed The Examiner reports that, speaking generally, great ignorance appears to prevail respecting marketing processes, notwithstanding the exhortations and advice from high quarters to study these questions

In Stage II of 1,038 candidates, 217 obtained first class certificates, 542 obtained second-class certificates, and 279 failed The Examiner draws special attention to the excellence of the papers worked at the July examination, which were so good as to leave the impression that they were a specially selected set In particular, the answers to question 9 were so thorough and detailed that they appeared to be the result of considerable practical experience in the operations described

In Stage I of 1,503 candidates, 140 passed with credit, 899 passed, and 464 failed The answers on the whole pointed to very careful preparation and to an improvement in the general standard of intelligence on the part of the candidates. Unfortunately, a good many scripts were marred by bad spelling and bad handwriting.

Railway Law and Practice. - There were 20 candidates in this subject, of whom 2 obtained first-class certificates, 12 obtained second-class certificates, and 6 failed. The candidates generally showed a satisfactory knowledge of railway law, and there was a distinct improvement in preciseness of expression, a point which in the past has often been a source of great weakness.

Railway Economics Of 12 candidates, 3 obtained first-class certificates, 6 obtained second-class certificates, and 3 failed. Most of the candidates had a very

weak grounding in elementary economics, and therefore had no sound basis on which to build their knowledge of this subject.

Shipping Law and Practice.—Only 30 candidates entered for this subject, and of these 5 obtained first-class certificates, 14 obtained second-class certificates, and 11 failed. A few of the candidates were well prepared, but in too many cases the issues raised were only half dealt with.

Law and Practice of Marine Insurance.—Of the 42 candidates in this subject, 11 obtained first-class certificates, 22 obtained second-class certificates, and 9 failed. The Examiner reports a considerable improvement in the standard of work as compared with that of 1928, and there is definite evidence of careful tuition. It is regrettable, however, that some of the papers were marred by bad spelling and bad grammar, which ought not to be possible in Stage III.

Stock Exchange Law and Practice.—There were 35 entries in this subject. In Stage III of 13 candidates, 3 obtained first-class certificates, 8 obtained second-class certificates, and 2 failed. The papers generally were well worked. It seems somewhat curious that the questions which were most poorly answered were those which called for any knowledge of arithmetic, and that apparently none of the candidates had any practical acquaintance with the principles of compound interest.

In Stage II of 22 candidates, 8 obtained first-class certificates, 10 obtained second-class certificates, and 4 failed. The general quality of the papers might have been better, and the Examiner reports that in some of them the spelling was noticeably bad.

Advertising and Salesmanship.—The number of candidates has risen this year to 101, as compared with 70 in 1928, and in view of the growing importance of the subject it may be expected that the total will continue to rise. 18 candidates obtained first-class certificates, 55 obtained second-class certificates, and 28 failed. Probably many would have received higher marks had they read the questions more carefully, and too few of them appeared to have had much practice in putting down their thoughts in a concise and definite manner.

French.—The total number of entries in this subject was 5,563. In Stage III there were 365, of whom 32 obtained first-class certificates, 195 obtained second-class certificates, and 138 failed. While the best candidates gave evidence that they possessed really valuable and accurate knowledge it is disappointing to find that the Examiner reports in many cases a lamentable weakness in grammar. Nobody can possess a satisfactory knowledge of a language until it is built up on a sound grammatical basis. This is surely an obvious truism, and yet there are people calling themselves educationalists who apparently think either that grammar is quite unimportant or that it may be picked up anyhow. Many of the commercial candidates were very unsuccessful in dealing with the commercial passages, which were not difficult and only contained phraseology with which they should have been familiar.

In Stage II of 1,750 candidates, 210 obtained first-class certificates, 645 obtained second-class certificates, and 895 failed. Here again, while some of the papers were quite good, the work in general was marred by a deplorable lack of thoroughness. Verbs had too often been only half learnt, tenses were confused, and expressions wildly guessed at without reference to their context. The number of candidates

who attempted the "Commercial" passages was very small, and their work on the whole was very poor indeed. Far too many of the candidates were quite unprepared to sit for an examination of this standard.

In Stage I there were 3,448 candidates, of whom 508 passed with credit, 2,078 passed, and 862 failed. The Examiner's reports on this Stage offer a striking contrast to those on Stages II and III. The results were most satisfactory. "For many candidates the paper was far too easy, and totals of 90 per cent. were by no means uncommon." The grammar, in particular, was of a high standard, and considerable attention had been given to irregular verbs. It is to be hoped that those who have done so well in Stage I will go on to raise the level of work in Stages II and III.

German.—The total number of entries in this subject was 570, as compared with 471 in 1928. In Stage III of 64 candidates, 22 obtained first-class certificates, 26 obtained second-class certificates, and 16 failed. Although the work did not reach the high standard of excellence which has been maintained for some years past, the results may be regarded as satisfactory; the translations into German and the essays were mostly good and some candidates showed that they possessed a very considerable acquaintance with German literature and history.

In Stage II of 176 candidates, 50 obtained first-class certificates, 67 obtained second-class certificates, and 59 failed. In the March examination the standard of accomplishment was higher than it has been for some time. The renderings into English were excellent and the essays were satisfactory. The papers worked in May and July, however, were not so good. Many candidates possessing an adequate vocabulary showed an almost complete disregard of grammar, and the translations into German showed a deplorable weakness in syntax

In Stage I of 330 candidates, 30 passed with credit, 156 passed, and 144 failed. The general level of the work was fairly satisfactory; the translations into German were somewhat better than usual, but the free compositions were often rambling and ungrammatical.

Italian.—There were altogether 114 candidates in this subject, as compared with 89 in 1928. In Stage III of 17 candidates, 8 obtained first-class certificates, 5 obtained second-class certificates, and 4 failed. The work generally was satisfactory and showed careful preparation on the part of the candidates.

In Stage II of 43 candidates, 9 obtained first-class certificates, 28 obtained second-class certificates, and 6 failed. The papers generally reached a fair standard, although a number of candidates revealed a very imperfect knowledge of Italian grammar.

In Stage I of 54 candidates, 4 passed with credit, 38 passed, and 12 failed. In this Stage the candidates' knowledge of Italian grammar was very defective.

Spanish.—The total number of entries was 908. In Stage III there were 104 candidates, of whom 10 obtained first-class certificates, 76 obtained second-class certificates, and 18 failed. The work maintained about the usual standard. In translation, composition and essay the answers were generally good, most of the candidates possessing a considerable vocabulary and power of expressing themselves correctly, if not always quite idiomatically.

In Stage II of 329 candidates, 22 obtained first-class certificates, 232 obtained second-class certificates, and 75 failed. The work, as a whole, was poor, the grammar was decidedly weak, and many of the candidates were not up to the standard required at this Stage.

In Stage I of 475 candidates, 28 passed with credit, 366 passed and 81 failed The work compares favourably with that submitted last year; the translations were well rendered, on the whole, and after reading the strictures of the Examiners in other languages, it is satisfactory to learn that the grammar questions were fairly well answered, though there is still room for improvement in this direction.

Russian.- There were 21 entries in all for this subject In Stage III of 8 candidates, 4 obtained first-class certificates, one obtained a second-class certificate and 3 failed. The work submitted was very encouraging The best candidates possessed wide vocabularies, and in one case the translation into Russian was almost faultless.

In Stage II of 5 candidates, two obtained first-class certificates, 2 obtained second-class certificates, and one failed The general standard was good and for the most part the grammatical questions were answered satisfactorily

In Stage I of 8 candidates, one passed with credit, 4 passed, and 3 failed. There was a noticeable improvement in grammar, but translation into Russian was still very weak.

Portuguese. Ten candidates entered for this subject In Stage III there were 5, of whom 3 obtained first-class certificates and 2 obtained second-class certificates In Stage II there were again 5 candidates, of whom one obtained a first-class certificate, and 4 obtained second-class certificates In neither Stage was there any failure. No examination was held in Stage I

Swedish.—This examination was only held in Stage II There were 7 candidates, of whom one obtained a first-class certificate, 4 obtained second-class certificates, and 2 failed

ORAL EXAMINATIONS

The results of the Oral Test, which is now compulsory for all candidates in the Advanced Stage of French, German, Spanish, and Italian, were again well up to the average, the figures being much the same as last year An important part of the Oral Test is the taking down of a passage dictated in the foreign language by the Examiner, and in the past this has been a source of great weakness with many candidates. It is gratifying to be able to state that the examiners now report a very great improvement in this branch of the examination

ORAL EXAMINATIONS HELD DURING 1929

Subject.	No. of Examination Centres.	No. of Examiners	No. of Candidates examined.	Passed with Distinction.	Passed	Failed
French	43	32	402	88	243	71
German	13	12	67	21	38	8
Spanish	15	13	102	32	56	
Italian	4	3	15	8	5	
	75	60	586	149	342	95

Group Certificates in Commercial Subjects.

The increase, noted in last year's report in the number of candidates entered from advanced classes in Elementary Schools and Central Day Schools has been well maintained. Most of these candidates take a number of subjects qualifying for the Group Certificate in Elementary Commercial Subjects. To gain this special certificate candidates must pass in Arithmetic, English and two other subjects within three consecutive years, but it is satisfactory to find that many pupils from Day Schools have no difficulty in passing in the necessary subjects in one year. In view of this it is hoped that pupils from these schools will enter in future for the more comprehensive Junior School Commercial Certificate Examination which is held in March and July.

The qualification for Group Certificates in the other two stages is as follows:—

Advanced Stage. Candidates must pass in the following four subjects in the Advanced Stage in three consecutive years: Book-keeping, Commerce, Economic Theory, and any one of the remaining subjects (other than Shorthand, Typewriting, and Précis-Writing), in which an Examination in the Advanced Stage is held.

Intermediate Stage. Candidates must pass in the following four subjects, either in the Advanced or Intermediate Stage, in three consecutive years: Arithmetic, Book-keeping, Commerce, and any one of the other subjects in which an Examination in the Intermediate Stage is held. (For the purpose of this Certificate, Shorthand and Typewriting are considered as one subject.)

The thanks of the Council are once more accorded to the Court of the Clothworkers' Company, who have generously renewed their grant of £10 towards providing medals in all the subjects of examination where the work of candidates attains a sufficiently high standard. There is no doubt that there is very keen competition for these medals, and that they have done much to maintain or raise the level of excellence in the papers worked.

SCHOOL AND JUNIOR SCHOOL COMMERCIAL CERTIFICATE EXAMINATIONS.

A new series of Examinations was instituted in 1927, specially designed for candidates from Day Schools. Two examinations were held this year in March and July.

The subjects of examination are:—

Compulsory Subjects. Arithmetic, Book-keeping, Economic Geography, English, History.

Elective Subjects. French, German, Spanish, Italian (not more than two foreign languages may be taken), Commerce, Shorthand, Typewriting (School Commercial Certificate only), Mathematics, and Natural Science (Physics, Chemistry and Botany). Candidates must take not less than two and not more than four of these subjects.

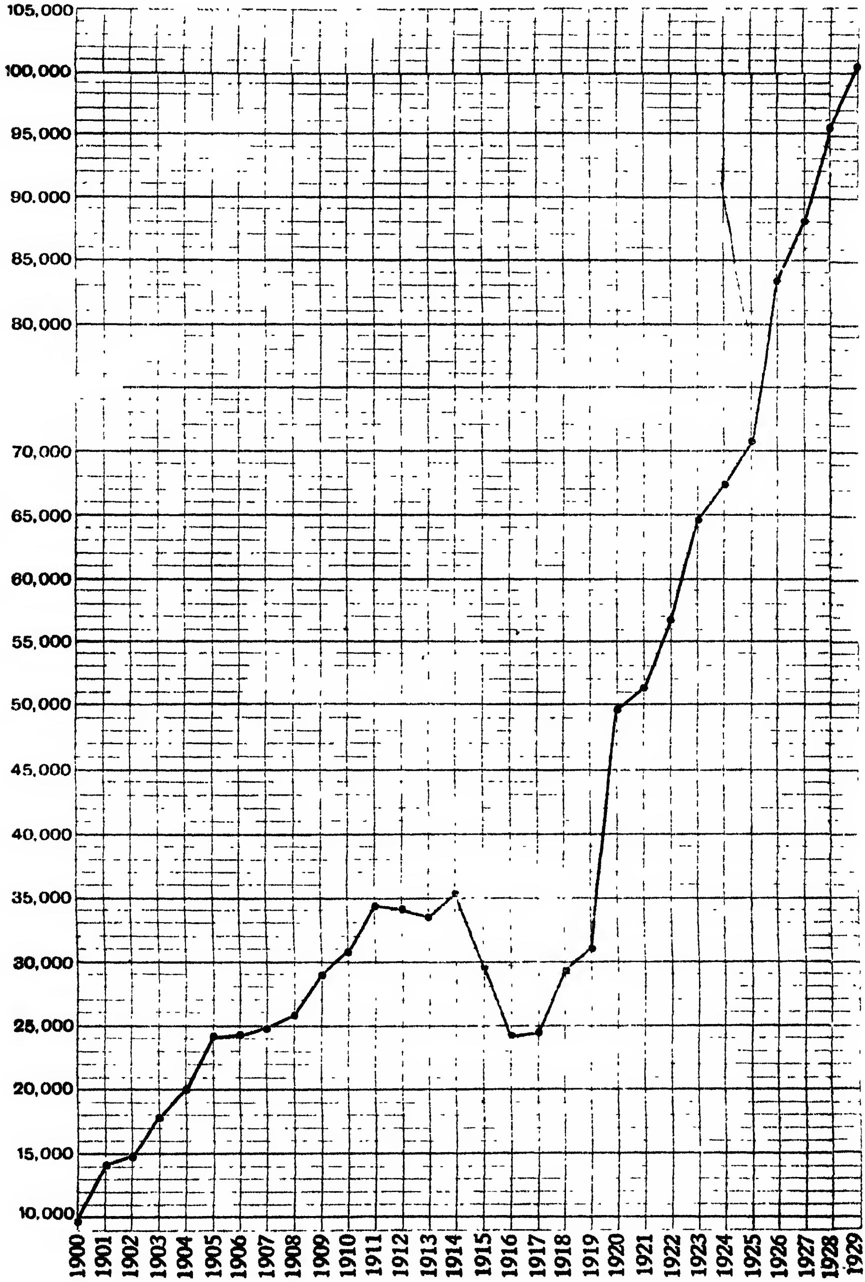
The total number of candidates was 875. Of these 148 entered for the School Commercial Certificate. Nineteen obtained first-class full certificates, and 70 obtained second-class full certificates. For the Junior School Commercial Certificate there were 727 candidates; 103 obtained first-class full certificates, and 286 obtained second-class full certificates. Candidates who failed to obtain full certificates received certificates for the subjects in which they passed.

DETAILS OF THE 1929 EXAMINATIONS.

Subjects	Stage III.—Advanced				Stage II.—Intermediate				Stage I.—Elementary				Total number of Papers worked in all Stages.	
	Papers worked	1st-class Certificates	2nd-class Certificates	Not Passed	Papers worked	1st-class Certificates	2nd-class Certificates	Not Passed	Papers worked	Passed with credit	Passed	Not Passed	1929	1928
Arithmetic	420	50	137	233	2,772	473	1,007	1,292	8,431	1,060	4,851	2,520	11,623	11,412
English	425	21	241	163	2,056	246	1,228	582	4,793	94	2,836	1,863	7,274	6,882
Book-keeping	3,689	398	1,540	1,751	8,553	1,278	4,810	2,465	12,047	963	7,202	3,882	24,289	23,862
Economic Geography	62	6	37	19	204	29	98	77	782	20	448	314	1,048	1,201
Shorthand	1,628	225	622	781	8,809	1,827	3,081	3,901	8,121	2,675	2,287	3,159	18,558	17,661
Typewriting	1,105	339	660	106	3,997	1,280	1,944	773	5,296	1,279	3,300	717	10,398	9,823
Economic and Social History ..	23	8	11	4	75	11	35	29	155	25	109	21	253	268
Economic Theory	191	17	116	58	376	58	245	73	—	—	—	—	567	500
Précis-writing	36	2	23	11	115	17	53	45	—	—	—	—	151	132
Commercial Law	160	67	84	9	359	199	130	30	—	—	—	—	519	530
Company Law	91	28	41	22	217	97	94	26	—	—	—	—	308	372
Accounting	480	28	240	212	—	—	—	—	—	—	—	—	480	542
Banking	15	2	9	4	—	—	—	—	—	—	—	—	15	17
Costing	93	5	46	42	—	—	—	—	—	—	—	—	93	99
Foreign Exchange	14	9	5	—	12	6	5	1	—	—	—	—	26	17
Commerce	331	9	185	137	1,038	217	542	279	1,503	140	899	464	2,872	2,492
Railway Law and Practice ..	20	2	12	6	—	—	—	—	—	—	—	—	20	33
Railway Economics	12	3	6	3	—	—	—	—	—	—	—	—	12	11
Shipping Law and Practice ..	30	5	14	11	—	—	—	—	—	—	—	—	30	47
Stock Exchange Law & Practice	13	3	8	2	22	8	10	4	—	—	—	—	35	34
Law and Practice of Marine Insurance	42	11	22	9	—	—	—	—	—	—	—	—	42	49
Advertising and Salesmanship	101	18	55	28	—	—	—	—	—	—	—	—	101	70
French	365	32	195	138	1,750	210	645	895	3,448	508	2,078	862	5,563	5,726
German	64	22	26	16	176	50	67	59	330	30	156	144	570	471
Italian	17	8	5	4	43	9	28	6	54	4	38	12	114	89
Spanish	104	10	76	18	329	22	232	75	475	28	366	81	908	935
Russian	8	4	1	3	5	2	2	1	8	1	4	3	21	18
Portuguese	5	3	2	—	5	1	4	—	—	—	—	—	10	16
Swedish	—	—	—	—	7	1	4	2	—	—	—	—	7	8
Totals, 1929 ..	9,544	1,335	4,419	3,790	30,920	6,041	14,264	10,615	45,443	6,827	24,574	14,042	85,907	—
,, 1928	9,763	1,190	4,801	3,772	30,075	6,425	14,664	8,986	43,479	7,663	22,602	13,214	—	83,317

In addition to the figures given above, 7,681 papers in the Elementary Stage were worked in May at the Group Course Examination for London County Council Junior Commercial and Technical Institutes, and 7,108 papers were worked at the Junior School and School Commercial Certificate Examinations held in March and July. The grand total of papers worked in 1929 is, therefore, 100,696.

DIAGRAM SHEWING NUMBERS OF PAPERS WORKED IN THE ROYAL SOCIETY OF ARTS EXAMINATIONS, 1900—1929.



In 1927 (the first year of this examination), the number of candidates was 312. In 1928 this number increased to 516, and in 1929 to 875

EXAMINATIONS FOR LONDON COUNTY COUNCIL JUNIOR COMMERCIAL AND JUNIOR TECHNICAL INSTITUTES.

At the request of the Education Committee of the London County Council, the Society undertook again to hold course examinations for (*a*) students in L.C.C. Junior Commercial Evening Institutes, and (*b*) students in L.C.C. Junior Technical Evening Institutes.

The total number of entries from both classes of Schools was 2,491 There were 1,627 candidates from the Junior Commercial Institutes, of whom 946 obtained group certificates; and 864 from the Junior Technical Institutes, of whom 513 obtained group certificates

NOTES ON BOOKS

THE BUILDERS OF AMERICA By E Huntington and L F Whitney London Chapman & Hall, Ltd 16*s* net.

Vagueness and uncertainty are incidental to a study of title page, preface and introduction, indications as to the real scope and purpose of this rather ponderous volume of xvi + 368 pages being somewhat obscure and doubtful until Chapter I of the text is reached.

First readings in the text will make it clear that the builders of whom the authors discourse are not precisely like such men of days gone by as Washington, Longfellow, or Franklin. The builders of the book under notice are in the main to be men of the future, characterised by "fine temperament, fine intelligence, and fine health," p. 1. On p. 23 this sentiment is emphasised, and it is made quite indubitable that the leading function of the builders is to solve problems arising out of the population question. This aspect remains definite to the end of the book, although occasionally obscured by a superfluity of words.

The primary standpoint of the authors is quite definitely contrary to that of certain persons who, in 1877, were prosecuted for publishing a pamphlet by Dr Knowlton which our law-courts held to be objectionable. The primary aspect in the Knowlton pamphlet is that well-intentioned persons should strive towards a lower rate of increase for themselves, but an eminent biologist having convinced one of the prosecuted persons that if the well-intentioned and intellectual classes reduce their output of children, something like racial suicide must follow, this propagandism by the Knowltonist party ceased or waned for a time.

It is now easy to understand the psychology of the authors in relation to their main proposition, that racial improvement depends on the good and the worthy having larger families than the average. Reading from p. 27 to p 30, we find an estimate, founded on actuarial data available in the United States, that the output of children required to keep the population stationary is 3.1, on the average, from each fruitful marriage; but the authors strive towards a material increase of this output from the high-minded and intellectual persons whom they classify as builders Apparently nothing short of an average increase of one per family from the intellectual builders will satisfy them, this making the average family of the intellectuals 4.1; but it is contended that to make the future of America safe, this output must be raised to about 4.5.

One aspect in the plan for arriving at the better status is touched upon where we read of the old Rabbinical teaching that a man should sell all that he has in order to obtain the daughter of a learned man as a wife (p. 73), and on p. 284 the authors appear to disclaim all wish for governmental control of marriage; but further on such control seems to be quite positively stated. Thus, towards the end of p. 284, we read: - "When eugenic ideas at last prevail among the great majority of sensible people, legislation will of course follow suit." On p. 285 this anticipated legislation is shown to us in a form which seems impossible in any civilised community or in any state upholding the Christian or Jewish religions. All those who are condemned as degenerate on any one of seven more or less specific counts, one of which counts is the rather indefinite "crime," and another the still less definite "- and the like'" are to be altered or unfunctioned so as to *eliminate child bearing*. To those who have studied the history of times long past such proposals bring visions in which the woman who has been altered and so protected against usual consequences, becomes a vivid and ever-active agent in spreading degenerations far transcending anything which has been attributed to the most lurid of modern nocturnal revels, as in some of the South European or Levantine night clubs, cabaret shows, or the like. The rites attributed to the worship of Astarté, the Phœnician Venus, called "Ashtoreth, the goddess of the Zidonians," in I Kings, *c.* xi, *v.* 5, may be mentioned as an exemplar.

The good intentions and sincerity of the authors are manifest, but to carry into effect their first-mentioned proposal may prove difficult and impracticable, as we know that all through organic nature the higher forms tend towards lower fecundity. The second proposal does not now loom before us very definitely or threateningly, so we can postpone a study of the various contentions that may be brought against it. Meanwhile the mind may not inaptly turn to a quotation which W. R. Grove, eminent as physicist, Queen's Council and Judge, presents to us on p. 78 of the 1855 edition of his "Correlation of the Physical Forces."

"Nature is made better by no mean,
But Nature makes that mean; so o'er that art,
Which we say adds to Nature, is an art
That Nature makes."

SPEECH AND HEARING. By Harvey Fletcher. (Introduction by H. D. Arnold.) London: Macmillan and Co., Ltd. 21s. net.

Dr. Fletcher in his Volume of 332 + xvi pages, with considerably over 200 definitely important and pertinent figures, gives a carefully ordered and lucid account of the remarkably rapid progress in our knowledge of Speech which characterises the century 1829-1929. We may regard the record and study by Dr. Fletcher as historically sequent to and fitting in with Sir David Brewster's account of Speech and its artificial reproduction; the scope ranging from conjectures as to the statue of Memnon to the year 1832.

Brewster's classic account of the early history of speech reproduction is contained in his "Letters on Natural Magic" (Physical Science), "addressed to Sir Walter Scott," and published by Murray in 1832. Much emphasis is given by Brewster to the means employed by Kratzenstein in constructing his "Talking Automaton" which, although not perfect was good enough to win the prize offered in the year 1779 by the Imperial Academy of Sciences at St. Petersburg, and Brewster's Fig. 47 (p. 207) shows us the devices by which Kratzenstein produced the five primary vowel sounds. In reference to this system mainly, Brewster on his page 211, makes a prediction as follows: " . . . we have no doubt that

before another century is completed a talking and a singing machine will be numbered among the conquests of science."

Dr. Fletcher's work, now before us for review, is, we consider, the first which indicates in clear theory and detail the realisation of Brewster's prediction published in 1832, and for this reason, even if no other, it should be a volume to add lustre to the reputation of the publishers. The author, Dr. Fletcher, on his page 8 and by his fig. 2 gives us thirteen aspects of mouth, lips and tongue, showing how pure-vowel sounds and diphthongs are produced; while fig. 3, on page 11, shows a scheme for originating artificially the fundamentals of speech.

We need not enlarge on this aspect—the origination of speech or song; but the available possibilities run through the book ready to be grasped by the inventor, as, for example, one who wishes to add words, perhaps in numerous languages, for synchronised use with an existing cinematograph film. As may be expected the bulk of the book deals with derived sounds which come by various means from actual sounds, the telephone and the Edison groove, as incised or pressed on a revolving cylinder or disc, figuring largely.

Noise, as distinguished from speech or song, is considered from many aspects. An almost ever-present source of noisy confusion is the distortion which reverberant rooms (whether at the source or destination), and the persistence or "over-hang" which reverberant objects produce. On pp. 202-205 we are given five graphs which, with the text, do much towards giving an insight into the almost ever-present reverberation impurities in speech-sound as it reaches the ear; but we must go back to p. 00 and very carefully study the chapter on noise, as distinguished from "pure tone," music, or speech, and devices are described by which approximate quantitative estimates may be made of noise. To give some idea as to one of the methods, reference may be made to p. 105, where we read how an artificial noise is balanced against the interfering noise.

Taking the work in all its aspects, it must be regarded as an essential addition to the library of every physicist, telephone-engineer, musician or orator who wishes to keep abreast with the rapid industrial progress of our times.

GENERAL NOTE.

ARTIST-CRAFTSMAN EXHIBITION, CENTRAL HALL, WESTMINSTER. This annual exhibition, which is held this year at the Central Hall, Westminster from Saturday, October 26th, to Wednesday, November 6th, inclusive (from 11 a.m. to 7 p.m.), consists of a representative display by a score of trained modern craftsmen practising the traditional crafts, including pottery, hand-made jewelry, iron and leather work, printing, illumination, weaving and other crafts. The exhibit by rural smiths and saddlers is a step towards the development of these crafts in other directions than in those merely auxiliary to the motor garage. The exhibition will include demonstrations of pottery making, etc.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, OCTOBER 28. Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Systematic Research by Industrial Undertakings." Opened by Colonel Sir T. F. Purves.

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Mr. B. A. Robinson, Chairman's Address.

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Geyl, "The Revolt of the Netherlands." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.[illegible] Rev. G. E. Newsom, "The Church and the World." [illegible]cture IV. The Reformation."

At University College, Gower Street, W.C. [illegible] p.m. Rev. Canon Claude Jenkins, "Religion [illegible] the Church in Shakespeare's Day."

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Brocklehurst, "Secretion of the Digestive Juices." (Lecture II.)

At University College, Gower Street, W.C. 5.30 p.m. Prof. J. Macmurray, "The Philosophical Approach to Modern Social Problems." (Lecture II).

TUESDAY, OCTOBER 29.. Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, "Anatomy—The Lower Limb. Its Connection with the Trunk. The Surface Forms dependent on Bone and Muscle in Action and Repose." (Lecture II).

Chadwick Public Lecture, at the British Medical Association, Tavistock Square, W.C. 5.15 p.m. Prof. J Boeke," The Histological Basis of Health Lecture I—The Tissues in Youth and Age."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds 7 p.m. Mr. T. Roles, Chairman's Address.

At the College of Science and Technology, Leicester 6.45 p.m. The Hon. Sir Charles A. Parsons and Mr J. Rosen," Direct Generation of Alternating Current at High Voltages."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Informal Meeting. Opener. Mr D Ross-Johnson.

University of London, at King's College, Strand, W.C. 5 p.m. Dr. J. W. Pickering, "Blood Plasma and Platelets" (Lecture IV).

King's College (at 40 Torrington Square, W.C.) 5.30 p.m Dr. J. Krzyzanowski, "The Polish Novel in the 19th Century. Lecture II—Henry Sienkiewicz and his Later Achievements."

At King's College, Strand, W.C. 5.30 p.m. Prof J. S. Mackenzie, "The Conception of a Cosmos."

At King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares," Russian History to 1861. Lecture III Break-up at Kiev: Migrations. The Tartars"

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m Prof Dr M J. Bonn, "Some Relations between Economics and Politics in present-day Germany." (Lecture I)

At St Thomas's Hospital Medical School, Albert Embankment, S.E. 5 p.m. Dr A St G Huggett, "The Physiology of the Fœtus" (Lecture IV)

WEDNESDAY, OCTOBER 30.. Eugenics Society, at Burlington House, W. 5.15 p.m Prof S. J. Holmes "The Biological Trend of the Negro"

Literature, Royal Society of, 2 Bloomsbury Square, W.C. 5 p.m. Ordinary Meeting

Mining Engineers, Institution of, Burlington House, W. Annual General Meeting. (1) Mr. H. Eustace Mitton, Presidential Address. (2) Mr. Robert Clive, "Abstract of Report on the Underground Conveying and Loading of Coal by Mechanical Means"

Public Health, Royal Institute of, 37 Russell Square, W.C. 4 p.m Dr. A F Hurst, "The Asthma Problem"

United Service Institution, Whitehall, S.W. 3 p.m Captain H. J. Feakes, R.A.N., "Australia's Part in Naval Defence."

University of London, at King's College, Strand, W.C 5.30 p.m Prof. E V. Appleton," The Contribution of King's College to the Advancement of Learning during the Century 1829-1928. Lecture IV—The Physical Sciences."

At King's College, Strand, W.C. 5.30 p.m. Dr. F. A. P. Aveling, "Personalism. A Psychological Approach to Reality. Lecture IV—The World of Ideal Experience."

At King's College, Strand, W.C. 5.30 p.m Mr. A. F. Meyendorff, "The Influence of Capitalism on Communism in Russia" (Lecture II).

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. Dr. M. J. Bonn, "Some Relations between Economics and Politics in present-day Germany." (Lecture II).

At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture IV on "Office Machinery."

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m Dr Alice Werner, "Kingdom of Congo."

At University College, Gower Street, W.C. 5.30 p.m. Major C. Davenport, "Beautiful Books."

At University College, Gower Street, W.C. 5.30 p.m. Mr. J. H. Helweg, "Copenhagen, Past and Present." (Lecture III).

THURSDAY, OCTOBER 31.. Arts Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, "Anatomy—The Lower Limb. Its Connection with the Trunk. The Surface Forms dependent on Bone and Muscle in Action and Repose." (Lecture II).

Automobile Engineers, Institution of, at the Queen's Hotel, Birmingham 7 p.m. Prof W. Morgan, Presidential Address, "The Member and the Institution."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m Prof. Eccles, "Montaigne" (in French). Lecture IV.

At King's College, Strand, W.C. 5 p.m Dr. J. A Hewitt, "Metabolism of the Carbohydrates and Fats." (Lecture III)

At King's College, Strand, W.C. 5.30 p.m. Mr. H W Steed," The Minorities Question and the Union of Europe Lecture III—The Value of Racial Individuality"

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m Prof Dr M J Bonn, "Some Relations between Economics and Politics in present-day Germany" (Lecture III)

At University College, Gower Street, W.C. 5.30 p.m Prof J E Neale, "The Elizabethan Parliament" (Lecture III)

FRIDAY, NOVEMBER 1. Anthropological Institute, at the Portland Hall, Great Portland Street, W. 5.30 p.m Prof. G. Elliot Smith, F.R.S., "The Evolution of Man."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m Mr E. W Hill (Chairman of the Meter and Instrument Section). Inaugural Address.

Junior Institution of Engineers, 39 Victoria Street, S.W 7.30 p.m Informal Meeting Technical Film, "The Age of Speed."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m Prof. H L. Callendar, "Critical Relations between Water and Steam" (Thomas Hawksley Lecture).

North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne. 6 p.m Mr. W. S Burn, "The Development and Performance of the Richardsons-Westgarth Oil Engine."

Philological Society, at University College, Gower Street, W.C. 8 p.m. Prof E. Weekley, "Words and Names,"

Public Health, Royal Institute of, 37 Russell Square. W.C. 5 p.m. Prof Dr. R A. Peters," Tissue Anarchy as illustrated by the present position of our knowledge upon the changes produced in the higher animal by lack of Vitamin B." (Harben Lecture).

University of London, at King's College, Strand, W.C 5.30 p.m H. E Dr. J. Gennadius, "Sources for the History of the Greek War of Independence."

At King's College, Strand, W.C. 5.30 p.m. Monsieur Pierre Hamp, "The French Novel. Lecture II—Le travail dans la littérature française."

At King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture III—Gogol and Sukhovo-Kobylin."

At King's College for Household and Social Science, 61 Campden Hill Road, W. 5 p.m. Prof. V. H. Mottram, "Human Nutrition." (Lecture III).

At University College, Gower Street, W.C. 5.30 p.m. Mr. C. S. Elton, "The Future of Animal Ecology." (Lecture II).

At University College, Gower Street, W.C. 5.30 p.m. Sir Richard Lodge, "English Parties and Foreign Policy in the Eighteenth Century." (Lecture I)

SATURDAY, NOVEMBER 2.. L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray "Ancient Egyptian Sculpture in Rleief."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4015. VOL. LXXVII.

FRIDAY, NOVEMBER 1st, 1929.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.(2.)

NOTICES.

OPENING OF THE 176TH SESSION.

The Opening Meeting of the 176th Session will be held at 8.30 p.m. on Wednesday, November 6th, when the Inaugural Address will be delivered by MR. LLEWELYN B. ATKINSON, M.I.E.E., Assoc. M.Inst.C.E., Chairman of the Council. The subject will be "Fifty Years of Electrical Science and Industry."

After the delivery of the Address, the Society's silver medals awarded for papers read last session will be presented.

Tea and coffee will be served in the Library at the end of the proceedings.

COUNCIL.

A Meeting of the Council was held on Monday, October 14th. Present:—Mr. Llewelyn B. Atkinson, M.I.E.E., in the Chair; Sir Charles H. Armstrong; Sir William Henry Davison, K.B.E., D.L., M.P.; Sir Edward Gait, K.C.S.I., C.I.E.; Sir Robert Abbott Hadfield, Bt., D.Sc., F.R.S.; Col. Sir Arthur Holbrook, K.B.E.; Mr. P. Morley Horder, F.S.A.; Sir Herbert Jackson, K.B.E., F.R.S.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Reginald A. Mant, K.C.I.E., C.S.I.; Mr. J. A. Milne, C.B.E.; Mr. James Swinburne, F.R.S.; Mr. Alan A. Campbell Swinton, F.R.S.; Sir George Sutton, Bt., and Mr. Carmichael Thomas, with Mr. G. K. Menzies, M.A., Secretary, and Mr. W. Perry, B.A., Assistant Secretary.

Mr. Alfred C. Bossom, F.R.I.B.A., was elected a Member of the Council in place of Mr. Alfred Carpmael, resigned.

The following candidates were duly elected Fellows of the Society:—

Banks, Percy H. B., A.R.I.B.A., Brighton.
Bittinger, Fritz John, Boston, Mass., U.S.A.
Clark, Professor George L., Ph.D., Urbana, Illinois, U.S.A.
Fisher, Joseph Alfred, Shortlands, Kent.

Gardiner, J. R., M.I.E.E., London.
Garland, Claude Mallory, Chicago, Illinois, U.S.A.
Grady, Ernest, Sheffield.
Hall, Frederick J. S., Rickmansworth, Herts.
Harrison, Maynard Colchester, Newport, Mon.
Horsfall, Herbert, Perth, Western Australia.
Lind, Walter P., Surbiton, Surrey.
McInnes, Alexander Neil, Littleover, Derby.
Mistry, Cursedji D., Bombay, India.
Needham, Albert, London.
Rai, Rai Bahadur Jagdish Narain, Gorakhpore, India.
Sett, Adi K., Bombay, India
Tier, Professor G., Prague, Czechoslovakia.
Walker, Frederic Joseph, Sydney, Australia.
Way, Allan Jay, Sydney, Australia.
Wilson, Oscar, Singapore, Straits Settlements.

The thanks of the Council were accorded to Sir Alfred Yarrow, Bt., F.R.S., for a donation of a hundred guineas towards the reduction of the debt on the Building Fund, which now amounts to about £4,000.

A report in connection with the reconditioning of West Wycombe was considered.

The arrangements for the meetings during the forthcoming session were considered.

It was reported that the various Sectional Committees of the Annual Competition of Industrial Designs were engaged in drawing up the programme for 1930.

A quantity of financial and formal business was transacted.

REPORT ON THE COMPETITION OF INDUSTRIAL DESIGNS, 1929.*

INTRODUCTION.

The Annual Competition of Industrial Designs was held for the sixth time this year. There was again an increase in the numbers over those of 1928, viz., 1,219 candidates and 3,669 designs, as compared with 1,024 candidates and 3,126 designs.

There are probably several reasons for this growth. In the first place the amount of the prizes offered was over £2,000, as against £1,600 in 1928. In the second place the Competition is coming to be more and more widely recognised as providing the best opportunities for young designers to show what they can do and of bringing them into touch with manufacturers and others

* Owing to considerations of space it has been found necessary to omit from the Report the lists of Central and Sectional Committees, of panels of judges, and of donors of prizes and scholarships. These however will be included in the separately printed Report which will be issued shortly.

likely to be able to make use of their services. Manufacturers also are appreciating more and more the assistance which the Competition gives them in discovering young talent, and a number of important firms have already signified their desire to offer prizes for the Competition of 1930. Appreciative leading articles drawing attention to the value of the movement have appeared in *The Times*, the *Manchester Guardian* and many other important newspapers, and no doubt, this publicity has done a very great deal to popularise the Competition.

There are always to be found a number of critics who complain that much of the work submitted shows lack of technical knowledge and is, therefore, unsuitable for immediate commercial reproduction. While it is, no doubt, desirable that more attention should be paid in the Schools of Art to the technical side of design, it should not be forgotten that most of the candidates in this competition are either still in the student stage or are only just out of it, and it is hardly fair to expect them to produce work which can be compared for technical excellence with the work of mature designers. While, therefore, they hope to effect a gradual improvement in this direction, the main object of the promoters of the scheme is to encourage those who possess ideas and originality, in the belief that a young artist of bright and fresh talent will soon acquire the necessary technical knowledge when he has opportunities of doing so. As evidence of this a designer who was given an appointment on the designing staff of a very large textile firm as a result of winning a Travelling Scholarship offered by them in 1927 has this year produced a "best seller," whilst another prize-winner of that year, who also received an appointment on winning a prize offered by another important textile firm, is also very highly spoken of by her employers.

In connexion with the question of technical requirements it is interesting to know that the Committee of the Advertising Section intend to issue for the information of competitors a memorandum on Poster Designing, which, embodying, as it will, hints and advice on the subject by leading practical men in this profession, should prove of great value to students of Schools of Art and others entering for this Section of the Competition.

But whilst a number of the Judges have commented somewhat severely on the lack of technical knowledge shown by the candidates, several of those connected with the textile trade who took part in the adjudication of this year's designs expressed their surprise at the high standard of excellence of the work submitted. It was a revelation to them to find so much native talent available in the country and, in several instances where manufacturers had just returned from the Continent, they frankly admitted that many of the designs entered for the Competition were quite as good as those for which high prices were being charged abroad.

A feature of this year's Competition is the success of candidates from the overseas parts of the Empire. The prize offered by the Orient Line for

a poster was won by an Australian; two important prizes went to Canada, and a prize for typography to an Indian student.

For the benefit of those whose work is approved by the Judges for exhibition, a Bureau of Information has been opened by the Society, for the registration of the names of those exhibitors who desire to obtain employment as designers. The information is placed at the disposal of manufacturers, and a number of appointments have been made in this way. Mention has already been made of two of them, and a third great textile firm have intimated that they are going to offer a post to the winner of their first prize in this year's competition. Besides these, other appointments have been made through the Bureau, and many more have been made without being reported to the Society, as manufacturers and publicity agents in search of designers with new ideas visit the exhibition each year in order to note the names and addresses of designers likely to suit their purpose.

The Council desire to express their thanks to those firms and individuals who have provided the scholarships and prizes, to the Judges who devoted much time and care to a very difficult task, to the authorities of the Imperial College of Science and Technology who provided accommodation for the reception of the designs, and to Lieut.-General Sir William Furse, K.C.B., D.S.O., Director of the Imperial Institute, through whose kindness the Society received permission to judge the designs and to hold an exhibition of selected work in the Exhibition Pavilion of the Institute.

Number of Entries

The total number of competitors who entered for the various sections of the Competition was 1,219. Of these, 901 were students of Schools of Art, and 318 non-students.

The number (of mounts) of designs submitted was 3,669, divided as follows:

Architectural Decoration	276
Textiles	1,475
Furniture	227
Book Production	139
Pottery and Glass	263
Advertising	1,289
Total for All Sections	3,669

Reports of Judges.

Art Congress Studentship.

The Art Congress Studentship of the value of £50, was open, under the conditions of the Competition to any candidate in any Section. The Studentship was awarded by the Judges to:

Miss Vera Maud Miller, Royal College of Art, for her designs Nos. 1226-1231 in Sub-section 5, No. 1230 in Sub-section 7, and No. 1217 in Sub-section 1, in the Textile Section.

SECTION I.—ARCHITECTURAL DECORATION.

SUB-SECTION 1. *Prize offered by the Royal Society of Arts under the John Stock Trust for a Design for the Proscenium Wall of a Cinematograph Theatre. Competitors must not be over 30 years of age.*

The awards are as follows :—

The Prize of £50 to Frederick Ernest Woolley, Nottingham School of Art (No. 3037 and No. 3038).

Commended :

John Grisedale Sidebottom, Leeds College of Art (No. 2177 and No. 2178)

The Judges are somewhat disappointed by the limited number of designs submitted, and in the still more restricted number of those which show adequate training for a subject of growing importance. This substantial prize should attract students of greater experience.

A common fault is incoherence of composition, a cramming together of disconnected and inharmonious styles.

The student before beginning his work should inform himself carefully of the requirements involved. F. E. Woolley, to whom the prize is awarded, has done this. His design shows restraint, a sense of proportion and is a well-rendered drawing, undoubtedly the best submitted. He has realised that the decoration of the proscenium is subordinate to the main purpose of the building, which is the cinematograph itself.

SUB-SECTION 2. *Prize offered by the Royal Society of Arts under the Mulready Trust for a set of three black and white drawings of Architectural Subjects in any town or district.*

The awards are as follows :

The Prize of £20 to Eric Frank Starling, Bartlett School of Architecture, University College (No. 1827).

Highly Commended :

Eric Frank Starling, Bartlett School of Architecture, University College. (Nos. 1828 to 1835)

The general opinion of the Judges was that the Drawings in this Sub-section reached a high degree of excellence, the pencil drawings of London buildings, awarded the first prize, being of a very high standard indeed.

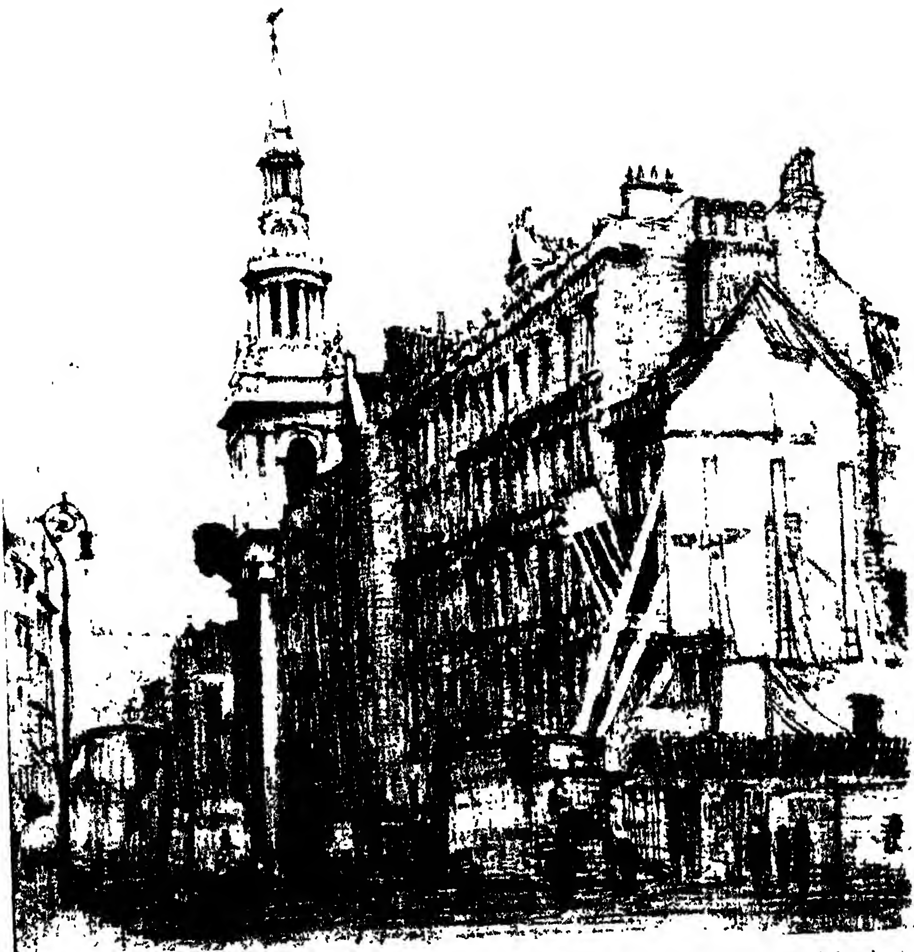
The author of the winning set should be encouraged to develop his skill. His work shows great promise but he should not allow his facility with the pencil to affect his studies as an architect.

SUB-SECTION 3. *Lewis Berger Scholarship of the value of £60, tenable at the Royal College of Art for a period of three months for the purpose of study in Decoration and Decorative Painting.*

The award is as follows

The Lewis Berger Scholarship of £60 to Carill John Hay Shaw, l'Ecole des Beaux Arts, Montreal. (Nos. 3656 to 3664).

The candidate has not been successful in interpreting the intention of the subject prescribed, and has failed to realise its full possibilities. With regard to colour, the green is not in keeping with the Adam period, being too harsh in tone, and, further, the condition that green was to be used was confined to the decoration for walls and ceilings. The polychromatic possibilities in the decoration of pilasters, entablature and mantelpiece have not been realised. The design for the ceiling, though neat in execution, is poor and incorrect in detail.



* St. Mary-le-Bow Church. Pencil Drawing by Frank Starling (Bartlett School of Architecture. London University), awarded a prize of £20.

Reproduced from *The Architects' Journal*, August 21st, 1929.

With regard to the "evidences of study," the Judges would have preferred sketches of historical or applied ornament.

In spite of these criticisms, however, the Judges have confidence in awarding the Scholarship as they feel that the candidate will derive much benefit from the course of study made possible by this Scholarship.

SUB-SECTION 4. *Prize offered by Messrs. Bagués, Ltd., for a design for a Decorative Metal Work Scheme for the Entrance Vestibule and the Main Entrance Hall of a Town Hall in an important maritime town.*

The awards are as follows :—

The Prize of £50 and an Owen Jones medal, to Leonard Whitaker, Leeds College of Art. (Nos. 2179 to 2184).

Highly Commended :

William Lewis Havard, Corsock, Stanley Avenue, Wembley. (Nos. 2491 to 2497).

The prize-winning design is good ; it displays a sense of composition and proportion and gives the effect of stateliness conforming to the requirements. It inclines, however, to over-much repetition of detail.

The designer is recommended to study the technical side of the metal craft

W. L. Havard's design (Nos. 2491 to 2497) is graceful and attractive, but more suitable for a Restaurant or Emporium than for a Municipal Building. It displays a poetic conception as regards the design of the balcony railing (the wavy handrail, however, is unfortunate) and the lift gates

The balustrade is too " copy book " in treatment and unsound from the practical point of view.

On the whole, the design lacks dignity and masculinity, but has a certain charm

The work in this Sub-Section was generally good and encouraging.

SUB-SECTION 5. *Prize offered by the British Commercial Gas Association for a Design for a Fire-place for a room and a Gas-fire of original design for use in connexion therewith.*

The Judges were unable to recommend that the full Prize of 50 Guineas should be given, but the following awards were made :

A Prize of £31 10s. to Philip Evans Palmer, 19, Handside Lane, Welwyn Garden City. (No. 1741).

A Prize of £10 10s. each to the following : -

Francis William Mudd, Leeds College of Art (No. 2186 and No. 2187)

James Henry Sellers, 78, King Street, Manchester. (No. 1271).

Commended :

John Breakwell, 35, Broadhurst Gardens, N.W.6. (No. 1361).

The problem of the gas-fire and its setting is so important that it is a little disappointing that only eleven designs were submitted. The solution proposed by Philip E. Palmer, who shows his gas-fire adapted to a new mantelpiece and to an old fireplace, shows careful thought and refreshing evidence of the fact that a gas-fire is something distinct from a coal-fire and demanding a modern note in its fashioning. F. W. Mudd and J. Henry Sellers have submitted some very good designs in a more conventional manner.

SUB-SECTION 6. *Prizes offered by the South Metropolitan Gas Company for (a) a Grate Front only of modern design, (b) a modern Fireplace to include a Metro Coke Grate, (c) a self-contained Fire for solid fuel incorporating the principles of the Metro Coke Grate, and (d) a Basket Grate incorporating the principles of the Metro Coke Grate.*

The awards are as follows :—

A Prize of £26 5s. to Frederick George Laming, 105, Drummond Road, S.E.16. (No. 484).

A Prize of £10 10s. to Frederick Rueben McCree, 33, Fenwick Road, S.E.15. (No. 917 and No. 918).

Commended :

Frederick George Laming, 105, Drummond Road, S.E.16. (No. 481, No. 482 and No. 483).

This Sub-Section proved disappointing. Only seven entries were received from three competitors, and the designs showed no outstanding originality or artistic merit. Four prizes were offered, but in view of the few entries the Judges were only able to award two. F. G. Laming submitted designs in all four divisions of this Sub-Section, the four designs being all modifications of one basic idea. Although the treatment was satisfactory, more regard might have been paid to cost of production and to economy of labour in maintenance. F. R. McCree's two designs for a coke grate front, although they were little more than detail modifications of existing designs, have sufficient merit, in view of the youth of the candidate, to deserve encouragement.

SUB-SECTION 7 (*a*). *Prizes offered by Messrs. Morris and Co. (Westminster), Ltd., for a design for a Staircase Window in a modern Departmental Store.*

The awards are as follows :—

Highly Commended :

Miss Isobel T. M. Goudie, 4, Royal Gardens, Stirling (No. 1899).

Commended :

Miss Maureen Stoddart, Nottingham School of Art (No. 3028 and No. 3029)

Miss I. T. Goudie's design (No. 1899) is good in general lay-out, but the dark grey glass would be unsatisfactory for the purpose. Miss M. Stoddart's designs (Nos. 3028 and 3029), and J. R. Sime's design (No. 541) show a good knowledge of material and construction

SUB-SECTION 7 (*b*). *Prizes offered by Messrs. Morris and Co. (Westminster), Ltd., for a design for a range of six windows for a Restaurant in a large city.*

The awards are as follows :—

The First Prize of £10 10s. to John Hammond Harwood, A.R.C.A. (Lond.), School of Art and Crafts, West Marlands, Southampton. (No. 1960 and No. 1961).

The Second Prize of £5 5s. to Arthur Edward Buss, 9, Lutwyche Road, S.E.6. (Nos. 643 to 648).

Commended :

John Rodger Sime, Nottingham School of Art. (No. 541).

The Judges regret the fewness of competing designs for an important craft. The rejected designs show to a marked extent the want of practical knowledge of the craft. Design No. 3030 shows invention, but not practical knowledge of the craft

J. H. Harwood's design (Nos. 1960 and 1961) shows well-designed windows of simple construction, a knowledge of materials and their possibilities, and is, with the exception of figure panels, well drawn and composed.

A. E. Buss's design (Nos. 643 to 648) is too small in scale, but would work out satisfactorily in larger windows ; the drawing and colour are good and the design shows decorative sense.

SUB-SECTION 8. *Prize offered by Mr. G. Paget Walford (Past Master of the Worshipful Company of Glaziers and Founder of the Walford Fund of that Company) for the best small Window or Medallion painted and glazed from an original design. Open to students and apprentices not exceeding 25 years of age.*

The awards are as follows :—

The Prize of £26 5s. to Miss Jean M. B. Paisley, Edinburgh College of Art. (No. 3444).

Highly Commended :

Walter J. R. Cook, Edinburgh College of Art. (No. 3418)

Commended :

Henry John Hunt, South London Art School. (Nos. 1414 and 1415 and Nos. 1416 and 1417).

*Winter. Painted window by Miss Jean Paisley (Edinburgh College of Art).

The Judges are pleased to express their great satisfaction with the excellent work submitted in this Sub-Section.

Although only four panels were sent in, it was hardly to be expected that many students would be in a position to incur the expense of producing the finished work.

* Reproduced from *The Architects' Journal*, August 21st, 1929.

Miss Jean M. Paisley's panel (No. 3444), which is awarded the prize, is excellent in design, workmanship and colour, in which W. J. R. Cook's panel (No. 3418) follows it very closely.

Nos. 1416-7, by H. J. Hunt, is quiet and restrained in colour, and the draughtsmanship is of a high order. Nos. 1414-5, by the same competitor, shows also great care and good drawing, though perhaps there is a little too much detail.

SUB-SECTION 9. *Prizes offered by the Malkin Tiles (Burslem), Ltd., for Designs for an all-tile and faience Fireplace, suitable for an entrance hall, lounge or dining room.*

The awards are as follows : -

A Prize of £17 10s. to Miss Edith Lois Martin, 8, Chester Road, Branksome Park, Bournemouth. (No. 103).

The second prize was not awarded. Several of the designs failed because, in the opinion of the Judges, they would be too difficult to reproduce owing to the large number of moulds required. Others failed because they did not indicate any period, as required by the conditions of the competition

SUB-SECTION 10. *Prizes offered by the London and North Eastern Railway Company for design of (a) a First Class Railway Compartment, (b) a Third Class Railway Compartment.*

The awards are as follows :

The First Prize of £25 to Richard Alfred Simons, c/o The Midland Bank, Ltd., Market Place, Leicester. (Nos. 1552 to 1554).

The Second Prize of £15 to Edward Thomas Ashmore Houldcroft, A.M.I.Mech.E., 341, Haydn Road, Nottingham. (Nos. 1320 and 1321).

Many of the entrants have failed to grasp the essentials, and have not displayed originality or inventive talent. The lines are too conventional and a failure to force the perpendicular lines is marked in most designs. The winning design, however, was a departure from tradition, and shows originality and cleverness, especially in its colour scheme. This design also has a certain amount of good minor features, such as electrical fittings, luggage racks, etc

The second prize is given to E. T. A. Houldcroft. The design that he has shown for a Third Class Compartment is considered preferable to his design for the First Class. He has shown originality in his electrical fittings and the disposition and arrangement of his minor features.

SECTION II.—TEXTILES.

SUB-SECTION 1. *A Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company, Limited, for a set of at least eight designs suitable for weaving or printing intended for Dress or Furnishing Materials. Competitors must not be more than 24 years of age.*

The Travelling Studentship of £75 offered by the Tootal Broadhurst Lee Company is awarded to :—

Norman Wilkinson, Manchester School of Art. (Nos. 3223, 3225, 3226, 3229, 3231 to 3234).

The following awards are also made :—

A Royal Society of Arts Prize of £10 and an Owen Jones Medal to Miss Anne Ethel Martin, Royal College of Art. (No. 1512 and No. 1514).

A Royal Society of Arts Prize of £3 to Miss Vera Maud Moller, Royal College of Art. (No. 1217).

Commended :

Miss Angela Bradshaw, Manchester School of Art. (No. 975).

Miss Betty Heesom, L.C.C. Central School of Arts and Crafts. (No. 1150).

Stanley James Robert Leeming, 14, Colne Road, Halstead, Essex. (No. 1165).

The competition, apart from the prize-winning designs, is disappointing, especially in comparison with that of two years ago.

More attention should be paid to balance of composition and finishing the design in a practical way. The Judges would again call special attention to the criticism contained in their report of last year :—" Extravagance in design is not necessarily originality and ingenious simplicity is not sufficiently considered. Further, fine taste in colour is wanted rather than multiplicity of colours in one scheme, and several designs, good in form, suffered from poor distribution and choice of colour."

The winner of last year's studentship, Miss Barbara Lebkuchen, has submitted an interesting set of designs.

SUB-SECTION 2. *Prizes offered by British Celanese, Limited, for designs for printing Silk Fabrics for Dress Wear.*

The awards are as follows.

The First Prize of £15 to Frank Grimshaw, 11, St. Patrice Street, Magog, Quebec, Canada. (No. 53 (*a*)).

The Second Prize of £10 to Miss Janet Dean, Royal College of Art. (No. 220)

An extra Prize of £5 to Arthur Hurman Hardstaff, Nottingham Correspondence College for Applied Designs (No. 1975).

Highly Commended :

Miss Dorothy Cartmell, Manchester School of Art. (No. 3474).

Miss Marian Forrest, Glasgow School of Art. (No. 3052).

Frank Grimshaw, 11, St Patrice Street, Magog, Quebec, Canada. (No. 53 (*b*)).

Miss Barbara Lebkuchen, Slade School of Art. (No. 1459).

Fred Marsden, Glossop School of Art. (No. 2260).

Commended :

Victor Roy Brown, L.C.C. Hammersmith School of Arts and Crafts. (No. 364 and No. 365).

Mrs. Dorothy Clark, Bournemouth School of Art. (No. 2734 and No. 2736).

Miss Ivy Gwendoline Collyer, Royal College of Art (No. 329).

Miss Mary Doreen Cooper, Royal College of Art (No. 326).

Frank Grimshaw, 11, St. Patrice Street, Magog, Quebec, Canada. (No 53 (*c*)).

Miss Florence Greenwood, Rochdale School of Art. (No 2816)

Harold Hemingway, Rochdale School of Art. (No. 2835).

Miss Barbara Jamieson Cochrane Highet, Glasgow School of Art. (No. 3054).

Miss Freda Mary Honour, Liverpool School of Art. (No. 3527).

Miss Barbara Lebkuchen, Slade School of Art. (Nos 1460 to 1462).

Harold Lecanski, Salford School of Art. (No. 1442).

Fred Marsden, Glossop School of Art. (No. 2263).

Miss Cicely Janet Mary Mason, Ruskin School of Drawing, Oxford. (No. 920).

Miss Mildred Ogden, 136, Burnage Lane, Levenshulme, Manchester. (No. 799 and No. 802).

Miss Alice Daisy Parkin, 75, Forest Road West, Nottingham. (No. 1339).

Miss Erica Margaret Payne, Manchester School of Art. (No. 3171).

Miss Doris Dale Pratt, Manchester School of Art. (No. 3193).

Miss Jean Marie Vaughan, 47, Belsize Square, N.W.3. (No. 1276).

Harold Watson, 12, High Street, Ware, Herts (No. 1759).

William Walker Watson, 40, Cranbrook Road, Gorton, Manchester. (No. 188).

George William Willis, 43, Caesars Walk, Cranmer Estate, Mitcham, Surrey. (No. 1307).

In view of the large number of entries in this Sub-Section (323) and the excellence of the best, it was decided to award a Third Prize of £5, in addition to the two prizes which were originally offered

From an inspection of the designs as a whole, it was very noticeable that, apart from prize-winners and those highly commended, competitors, whilst frequently displaying *artistic* merit, showed a lack of acquaintance with present-day fashion and tendencies for women's dresses.

The colourings chosen for the sketches were frequently unfortunate, and competitors should endeavour to cultivate a better feeling for colour. The water colour paints almost invariably used do not flatter the designs as much as the heavier pigment used by continental designers.

* Design for cretonne by Mrs. Kathleen H. Sargeaunt awarded the first prize in Sub-Section (3) of the Textile Section.

SUB-SECTION 3 *Prizes offered by Messrs Simpson and Godlee, Ltd., for Designs for Cretonne.*

The awards are as follows:

The First Prize of Thirty Guineas to Mrs Kathleen Hamilton Sargeaunt, Eaglehurst, Douglas, Isle of Man. (No. 277).

The Second Prize of Twenty-five Guineas and an Owen Jones Medal to Miss Margaret Rae Crow, Edinburgh College of Art. (No. 3420).

The Third Prize of Twenty Guineas to Ronald Stephen McArthur, Edinburgh College of Art. (No. 3432).

* Reproduced from *The Cabinet Maker*, September 7th, 1929

* Design for cretonne (highly commended) by Miss Vera M Moller who was awarded the Art Congress Studentship.

The Fourth Prize of Fifteen Guineas to Mrs Marjorie Reynolds, 112, Gordon Road, Camberley, Surrey. (No. 1981)

The Fifth Prize of Ten Guineas to Alfred Edward Stenlake, 32, Victoria Road, N.W.1. (No 1714).

Highly Commended .

Miss Vera Maud Moller, Royal College of Art. (No 1224).

Miss Cecil Helen Wood, L C.C. Central School of Arts and Crafts (No. 1770).

Commended :

Miss Margaret Crees, Swindon School of Art (No. 2331)

Miss Betty Whitson Gifford, Goldsmiths' College School of Art. (No. 774).

The entries in this Sub-Section were numerous and contained much work of merit. The designs kept to the required specification and showed a pleasing advance on the standards of previous years. In a number of cases, however, there was not much freshness of treatment, and competitors should be warned that, whilst due regard must be paid to tradition, it is hopeless to continue to exploit out-worn formulæ.

The Judges were glad to be able to award all five prizes, and to make two awards of "highly commended" and two of "commended."

* Reproduced from *The Cabinet Maker*, September 7th, 1929.

SUB-SECTION 4. *Prizes offered by Messrs. Turnbull and Stockdale, Ltd., for the two most original designs intended for machine-printed or hand-block-printed Cotton or Linen. Open to students, or designers serving apprenticeship, not exceeding* 24 years of age.

The awards are as follows :—

The First Prize of £15 to Alexis Dods Revolta, Jun., Edinburgh College of Art. (No. 3448).

The Second Prize of £10 to Miss Betty Heesom, L.C.C. Central School of Arts and Crafts. (No. 1153).

Highly Commended :

William Stewart Kennedy Smith, Edinburgh College of Art. (No. 3454).

Miss Phyllis Mary Steanes Willis, Royal College of Art. (No. 1292).

Commended :

Miss Gladys Atkinson Brailsford, Battersea Polytechnic School of Art. (No. 2536).

Miss Barbara Grace Morgan, L.C.C. Central School of Arts and Crafts. (No. 349).

William Thomson Russell, Glasgow School of Art. (No. 3093).

Miss Doris Stell, Royal College of Art. (No. 360).

Miss Margaret Dun-Waters Tennant, Glasgow School of Art. (No. 3073).

Miss Dorothy Willington, Liverpool City School of Art. (No. 3587).

This was a very large, but, on the whole, a disappointing competition, there being very little which was suitable for cotton or linen prints. There was disclosed a too general tendency towards extravagant pictorial motives. The Judges regret that too little interest was shown for plant form and that when used this was either simply reminiscent or a copy of an exotic continental type of design. They strongly advise a closer study of nature.

SUB-SECTION 5. *Prizes offered by Messrs. Warner and Sons, Ltd., for sets of six Designs for Printed Furnishings—the designs to be of natural flowers for use in small rooms.*

The awards are as follows :—

A First Prize of £30 to Miss Vera Maud Moller, Royal College of Art. (Nos. 1226-1231).

A Second Prize of £25 to Miss Esmé Caton, Croydon School of Art. (Nos. 2048-2053).

A Third Prize of £20 to Miss Ethel Mary Pierpoint Sexton, 4, Risbygate Street, Bury St. Edmunds, Suffolk. (Nos. 547-552).

Highly Commended :

Thomas James Corbin, Royal College of Art. (No. 1372).

Miss Elsie Frederica Horn, Goldsmiths' College School of Art. (No. 887).

Miss Barbara Eva Lebkuchen, Slade School of Art. (No. 1479).

Miss Ena Mary Winkley, St. Helise, Woodside Avenue, N.10 (No. 1301).

Commended :

Miss Ivy Gwendoline Collyer, Royal College of Art. (No. 333).

Miss Ena Muriel Russell Higson, 27a. Ebury Street, S.W.1. (No. 1129 and No. 1130).

Miss Margaret Louise Parr, Manchester School of Art. (No. 3170)

William Thomson Russell, Glasgow School of Art. (No. 3100).

On the whole, the Judges are satisfied with the works sent in for these prizes. Students are showing better appreciation of the capacities of the printing machine,

and the Judges are pleased to see that originality has been rather stimulated than otherwise by taking the necessary limitations into account.

The stipulation that the designs for these prizes were to be "of natural flowers for use in small rooms" provides sufficient explanation of the suggestion of monotony which otherwise might be judged to be a defect in considering the whole group of works submitted. Some limitation in the scale of the designs was also implied in the requirement that they should be suitable for use in small rooms. Bearing these circumstances in mind, the Judges have selected Miss V. M. Moller's design (No. 1226) for the first award, but as the prize was to be given for the set of six designs and the standard is not maintained in the other five works submitted by this student, the Judges have decided to take advantage of the discretion reserved to them. They make an award of £30 in this instance, instead of £50, and they constitute a third prize of £20 with the balance left over. The design selected for the first award shows an effective grouping of natural forms, aided by skilful distribution of colour.

The second prize of £25 is awarded to Miss Esmé Caton's designs (Nos. 2048-2053). The standard is here better maintained in all the six works submitted, and the terms of the competition are carefully observed The colour schemes tend to err on the side of dullness, and with a brighter background the key would need to be raised throughout.

The third prize of £20 is awarded to Miss F M. P Sexton's designs (Nos. 547-552). The designs submitted by this student are somewhat more conventionalised, but not beyond the limits laid down. The best of the six is No. 552, which is admirably balanced, both as regards composition and colour

No 1372, by T J Corbin, is highly commended, though it strays from the conditions of the award The design is one of the most original in the whole group

No. 1301, by Miss E. M. Winkley, is also highly commended. It recalls the floral designs of a generation ago, but the treatment of the background redeems it from the suspicion of being merely old-fashioned

No. 1479, by Miss Barbara Lebkuchen, is highly commended for vitality in design and harmony in colour.

No. 887, by Miss E. F Horn, gains equal commendation, though the larger scale of the design would tend to dwarf a small room, and the thinness of the colouring would have a monotonous effect.

The work of Miss I. G. Collyer (No. 333) is commended for merit in arrangement of motive and colouring.

Other designs commended are No. 3100 by W. T. Russell, Nos. 1129 and 1130 by Miss E. M. R. Higson, and No. 3170 by Miss M. L. Parr. No. 3100 has decided originality. In No. 1129 a suggestion of landscape is imparted without loss to the design as a whole. No. 1130 shows a successful grouping of natural floral motives, but the colouring is somewhat weak. The arrangement of the motives in No. 3170 is skilful, but the conventionalisation hardly brings it within the terms of the competition.

SUB-SECTION 6. *Prize offered by Messrs. G. P. and J. Baker, Ltd., for a design suitable for Hangings—the subject of the design to be inspired from Spanish embossed leather work.*

The awards are as follows:—

A Prize of 20 Guineas each to

Miss Marian Graham, Royal School of Needlework (No. 1394), and

Miss Leonora Kathleen Silver, Royal School of Needlework. (No. 1269).

Highly Commended :

Miss Freda Maxwell, Manchester School of Art. (No. 3158).

Commended :

Miss Edith Louisa Vaughan Ailsby, 45, Seagrave Road, Fulham, S.W.6. (No. 1804).

Miss Ida Marion Dight, Brackley, Crofton Lane, Orpington. (No. 625).

Miss Rosalie Handley, L.C.C. Central School of Arts and Crafts. (No. 893).

The stipulation that the designs in this Sub-Section should be suitable for hangings "to be inspired from Spanish embossed leather work" may have led to some little misconception as to what was really meant. However, taken as a whole, the designs show an appreciation of the subdued brilliancy of lacquered and embossed leather when used for wall-hangings or screens.

As two designs appeared to be of equal merit, Messrs. G. P. & J. Baker generously increased the amount of the prize money from 25 to 40 guineas, which has enabled the Judges to award two prizes of 20 guineas each to Miss M. Graham (No. 1394) and Miss L. K. Silver (No. 1269). No. 1394 approaches more nearly to the terms of the competition than any other design submitted, and it is adaptable for reproduction. The blue canopy is perhaps a little over-accentuated for a repeating pattern.

No. 1269 shows qualities of design not seen elsewhere in this group. The natural treatment of the flowers is happily combined with formal motives.

No. 3158, by Miss Freda Maxwell, is highly commended. It is perhaps the most modern and original design in the group. But for a lack of emphasis in the colour scheme it would have earned a higher award.

Miss R. Handley's design, No. 893, is commended. With a little more pains it might have been admirable. As it is the design tends to fall to pieces through lack of a central idea, and the colour scheme has similar drawbacks.

Miss I. M. Dight's design (No. 625) shows a sense of form and colour which is also to be commended. No. 1804, by Miss E. L. V. Ailsby, is commended for praiseworthy treatment in a modern way. The designs submitted in this Sub-Section tend to show more concentration on pattern than on colour. It may be that the students have had in mind the mellow effect of old leather without associating with it the lively colouring often used in such decoration.

SUB-SECTION 7. *Prizes offered by Messrs. Courtaulds, Ltd., for sets of twelve Designs for Plain and Figured Furnishing Fabrics.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A Prize of £10 each to the following :—

Miss Vera Maud Moller, Royal College of Art. (No. 1239).

Donald Lewis Rayner, Manchester School of Art. (No. 519).

The Judges are disappointed with the small number of designs submitted. The work generally shows lack of technical knowledge, which possibly accounts for so small an entry.

SUB-SECTION 8. *Prizes offered by Messrs. Lister and Co., Ltd., for Designs suitable for (a) Figured Moquette for Furniture Covering, (b) Furnishing Damask, and (c) Shaft Furnishing Moquette.*

The Judges were unable to recommend that the full Prizes should be given, but the following award was made :—

A Prize of £10 to Joe Moore, International Correspondence Schools, Ltd. (No. 119).

In Figured Moquettes none of the designs submitted were considered of sufficient merit or originality to warrant the award of a prize.

In Damask, while none of the four designs submitted were outstanding in style or originality, J. Moore's design was considered to merit recognition.

In Shaft Moquette only one design was submitted, and this did not fulfil the conditions specified, and was not practical for weaving on a shaft loom.

The Judges regret the extremely small number of designs submitted for all the divisions of this Sub-Section. They feel that this may be due to lack of technical knowledge of this class of woven fabrics and suggest it would be of considerable value if more instruction could be given on weaving conditions and the construction of these classes of fabrics which are of considerable importance in the furnishing trade.

If this could be done, they feel sure that entries would be largely increased and a higher standard obtained

SUB-SECTION 9. *Prizes offered by Messrs. Brintons, Ltd., for a Design for a Wilton or Axminster Carpet suitable for a Theatre, Showroom, or Hotel.*

The Judges were unable to recommend that the full Prizes should be given, but the following awards were made :—

A First Prize of £12 to Walter Shepherd, Kidderminster School of Art. (Nos. 2793 and 2794.)

A Second Prize of £10 to Walter Shepherd, Kidderminster School of Art. (Nos. 2795 and 2796.)

A Third Prize of £8 to Frank Victor Rogers, Kidderminster School of Art. (Nos. 2791 and 2792.)

Highly Commended

Mis Vera Maud Moller, Royal College of Art (Nos. 1245 and 1246)

Commended :

Frank William Evans, Kidderminster School of Art. (Nos. 2759, 2760, 2761 and 2762.)

Herbert Gordon Fry, 1179, King Street West, Toronto, Ontario, Canada. (Nos. 41 and 42)

Charles Robert Millward, Kidderminster School of Art. (Nos. 2779 and 2780.)

George Graham Quick, Kidderminster School of Art. (Nos. 2787 and 2788.)

The works submitted in this group reach a fair average level, but the Judges are unable to single out any one design as meriting the First Prize of £20. The sum is, therefore, divided. On the whole, W. Shepherd's design Nos. 2793/4 appears the best. The effect of the main design is somewhat frittered away by borrowing so much from it in the composition of the border, and more colours are used than are warranted by the effect arrived at.

The Second Prize is awarded to the same student's design Nos. 2795/6. The variety of motive combined with relatively few colours is much to be commended and the colour scheme is easily susceptible of variation. On the other hand, the border is too crowded and the scale is unduly small when compared with the main design.

A third prize is given to F. V. Rogers's design Nos. 2791/2. The composition of the main design is happy. It would require an unusually fine texture, but not beyond practicable limits. The colour scheme is good.

Nos. 1245/6 by Miss V. M. Moller is highly commended. It shows vitality and the balance of the main pattern and border is good. The skilful use of few colours is also to be noticed.

Nos. 2779/80, by F. W. Evans, is commended as a very practical design. The limitations of the fabric are well regarded, and the colour scheme could be varied if required without detriment to the pattern. Nos. 2787/8, by G. G. Quick, is also commended for general qualities of design and colour, though the tapering lines used here and there would not be practicable for the loom. A similar criticism may be passed on Nos. 2759/60, which is also commended. Some of the lines are too fine. Nos. 41/2, by H. G. Fry, is commended as a well-balanced design in the modern manner. Another design of modern tendencies is Nos. 2761/2, by F. W. Evans. It is commended for the effective combination of straight lines with floral motives.

SUB-SECTION 10. *Prizes offered by Messrs John Crossley and Sons, Ltd., for a Design (a) for an Axminster Carpet suitable for a Drawing Room, (b) for a Wilton Carpet suitable for a Drawing Room.*

(*a*) The Judges were unable to recommend that the full amount of the Prizes should be given, but the following awards were made.

A First Prize of £10 to Geoffrey Isaac Foreman, 11, Westgate, Halifax. (Nos. 876 and 877.)

A Second Prize of £5 each to Frank Heaton, Elder Bank, Walsden, Near Todmorden, Lancs (Nos. 249 to 251).

Albert George Phipps, Kidderminster School of Art. (Nos. 2783 and 2784).

Commended:

Herbert Richmond, Halifax School of Art. (Nos 2596 and 2597)

(*b*) The awards are as follows:

The First Prize of £20 to Walter Shepherd, Kidderminster School of Art (Nos. 2799 and 2800)

Commended:

Harold J. Watkins, 144, Park Street, Kidderminster. (No 968)

The entry was small for both divisions of this group, presumably because some acquaintance with the technique of carpet-weaving by machinery was involved. The designs submitted were disappointing as a whole Even among so few there were several which would not be easily adaptable to the requirements of the loom

In Division (*a*) of this Sub-Section, the work showing most merit is G. I. Foreman's design Nos. 876/7. It is thought that the sickle-shaped curve of the chief figure in the design would gain too much emphasis by repetition over a large surface. Nevertheless, the treatment of the background with mountainous landscape and water lilies is well in harmony with the rococo suggestion of the main motive. The colouring is good and the design practicable. A. G. Phipps's design Nos. 2783/4 shows imagination in design, though the distribution of the colours might have been simplified without corresponding loss of effectiveness. F. Heaton's design Nos. 249/51 is meritorious as a whole, but the cloud and water motive of the border does not seem altogether in harmony with the central pattern, and the colouring has a parched effect.

Nos. 2596/7, by H. Richmond, shows promise and is highly commended The formality of the background is a good foil to the main design.

In Division (*b*) W. Shepherd's design Nos. 2799/2800 receives the First Prize. The Chinese inspiration of this design is obvious, but it is interpreted with imagination and an appreciation of the public requirements at the present day. This design is the outcome of a more "practical" outlook than is shown in the other works submitted in this group.

A second prize is not awarded as no other work reaches the required standard.

No. 968, by H. J. Watkins, is commended for originality in design, but there

is a tendency to a harsh note in the colour scheme, which might, moreover, be liable to be less pleasing under artificial light.

SUB-SECTION 11. *Prizes offered by Messrs. Tomkinsons, Ltd., for a Design for an Axminster Carpet showing indications of Chinese influence suitable for a Drawing Room.*

The Judges were unable to recommend that the full amount of the Prizes should be given, but the following awards were made :—

A First Prize of £10 to Frederick Enoch Raymond Everley, Kidderminster School of Art. (Nos. 2765 and 2766.)

A Second Prize of £5 to William Eric Phillips, Kidderminster School of Art. (Nos. 2781 and 2782).

A Third Prize of £3 to David Edgar Morris, Kidderminster School of Art. (Nos. 2777 and 2778).

The entry was poor and the quality not good enough for a recommendation for the full amount of the first prize. The competitors do not seem to have much idea of Chinese carpets either in colour or design, and the entries seem more inspired by prints or embroidery or even by western fabrics of a Chinese style. F. E. R. Everley's design Nos 2765/6 would be better if the ground were brighter, but the pattern is well adapted for a repeat. W. E. Phillips's design Nos. 2781/2 is more like a chintz than a carpet in design. D. E. Morris's design Nos. 2777/8 would be better if the ground were a Chinese yellow.

SUB-SECTION 12. *Prizes offered by Messrs. Harold Finlinson, Ltd., for two sets of Designs (each consisting of three colour schemes) suitable for Oriental Carpets.*

The Judges were unable to recommend that the full amount of the Prizes should be given, but the following award was made :—

A Prize of £10 10s. to Miss Margaret Ellen Hays, The Mythe, Bognor. (Nos. 775 to 780).

The entries in this Sub-Section were disappointing, both in number and quality. The competition called for treatment in Oriental styles. The results have shown failure in this respect, save in the case of Miss M. E. Hays, who has shown some feeling and appreciation for the Oriental style. Her work possesses originality and shows perception. It would have been better if she had treated the field of the carpet with some pattern work instead of leaving it so plain.

SUB-SECTION 13. *Prize offered by the late Mrs. Lewis Foreman Day for a Design for a panel of Embroidery.*

The awards are as follows :—

The Prize of £10 to Mrs. Agnes Hoad, 142, Kingshall Road, Beckenham, Kent. (No. 343).

A Royal Society of Arts Prize of £3 3s. to Miss Muriel Walker, Manchester School of Art. (No. 3221).

Highly Commended :

Miss Nancy Guest, Manchester School of Art. (No. 3120).

Miss Sheila Margaret Knox, Manchester School of Art. (No. 3130).

Commended :

Miss Gladys Atkinson Brailsford, Battersea Polytechnic School of Art. (No. 2534).

Miss Lena Elizabeth Cole Northampton School of Arts and Crafts. (No. 2217).

Miss Phyllis Joyce Walkey, Northampton School of Arts and Crafts. (No. 2219).

There was a good entry for this competition, but the standard was not as high as last year. Many of the designs were too weak or too conventional, and only a few show real originality. An adaptation of an old design cannot be called original, and aniline colours should not be confused with bright colours. Nursery subjects and art needlework were also in evidence, but had no distinctive qualities. The first prize subject is carefully designed, both for composition and workmanship. The second prize is an original subject and some of those commended are also modern and well conceived. It is this modern and original note in these entries which makes this competition a distinct success.

SUB-SECTION 14. *Prizes offered by Messrs. A. Herbert Woolley and Co., Ltd., for (a) a Design for a Lace Flounce and (b) for a set of Designs suitable for trimming Ladies' Underclothing to be made on Lever's Lace Machine.*

The awards are as follows :—

(*a*) A First Prize of £8 to William Rowland, Nottingham School of Art. (No. 3017).

A Second Prize of £5 to William Guildford Martin, Nottingham School of Art. (No. 3009).

(*b*) A First Prize of £5 to Geoffrey Ross Dearden, Nottingham School of Art. (No. 2997).

A Second Prize of £2 to Miss Winifred E. Bexton, Nottingham School of Art. (No. 3468).

It is to be regretted that there was not a greater number of designs, although several of those submitted show considerable originality. The flounce design which receives the first prize indicates a good practical knowledge of the technical processes, and that to which the second prize is awarded has originality. Among the designs for trimming underclothing that obtaining the first prize has distinct character ; the second prize is given to a design graceful in treatment, although it presents certain difficulties in execution.

SECTION III.—FURNITURE.

SUB-SECTION 1. *Prizes offered by the Royal Society of Arts for Designs for a Scheme for the complete Decoration and Furnishing of a Middle-class Bedroom. The treatment to be essentially modern in character, particular attention being paid to utility and convenience.*

The Judges were unable to recommend that the full amount of the prizes should be given, but the following awards were made :—

A First Prize of £15 to Harold John William Hyde, 8, Vernon Terrace, Bath (No. 247 and No. 248).

Two Second Prizes of £10 each to :

Frederick Norman Cater, Westminster Technical Institute. (No. 1599 and No. 1600).

Cyril Leslie Charles White, Nottingham School of Art. (No. 3039 and No. 3040).

Highly Commended :

George Beaumont, 5, Hungerford Road, Edgerton, Huddersfield. (Nos. 1993 to 1996).

Arthur Edward Harvey, A.R.C.A. (Lond.), 7, Flat, Southdown Avenue, South Road, Handsworth, Birmingham. (Nos. 63 to 68).

Commended:

Maurice Godden, L.C.C. School of Building. (Nos. 634 to 636).

Frank Leslie Keep, High Wycombe School of Art. (No. 2100 and No. 2101).

Basil Procter, Crichton Hall, Dumfries. (No. 1922 and No. 1923).

Donald Milne Williamson, Sheffield College of Arts and Crafts. (Nos. 2908 to 2912).

The Judges were glad to note a general and serious attempt to tackle the conditions of the competition. They admire the industry and enthusiasm which must have been expended in the preparation of the drawings, many of which were well executed and workmanlike. On the other hand, the Judges regret that no one competitor reached a standard which justified the full award. Too much attention has been given to unnecessary detail or superfluous ornament. Design No. 247, for which the first prize was awarded, is spacious in planning though lacking in wardrobe accommodation. The Judges feel that there is still ample room for improvement in the right understanding of design in relation to material and space.

SUB-SECTION 2. *Prizes offered by the Royal Society of Arts for Designs for an Office Desk Chair of the revolving type, to cost about £12.*

The awards are as follows:—

The First Prize of £10 to George Francis Bungay, 11, Hardenwaye, Totteridge, High Wycombe, Bucks. (No. 992).

A Prize of £2 10s. to John Frederick Mole, High Wycombe School of Art. (No. 2108).

The Judges considered that No. 992 was an exceptionally good design, worthy of the full prize and deserving of special commendation. The drawing was also very crisp and clear.

SUB-SECTION 3. *Prizes offered by the London Cabinet and Upholstery Trades Federation for Designs for Dining Table, Dining Room Chairs and Sideboard in a restrained modern style.*

The awards are as follows:—

A First Prize of £15 to Edwin Lewis Clinch, High Wycombe School of Art. (No. 2090 and No. 2091).

Two Second Prizes of £5 each to:

Albert Ronald Liddicoat, Shoreditch Technical Institute (No. 1195 and No. 1196).

George Stirling, c/o Fergusson, 4, Holmfauldhead Drive, Govan, Glasgow. (No. 1727 and No. 1728).

Highly Commended:

Duncan McCallum Grassie, 14, Blythswood Terrace, Saudy Road, Renfrew. (Nos. 1910 and 1911 and Nos. 1912 and 1913).

Miss Diana Helen Woolston, Student of Mr. J. H. Roberts, 30, Royal Crescent, W.11. (No. 2509 and No. 2510).

The designs as a whole show too much insistence upon "Monolithic" motives without due regard for the practical use of sideboards and tables.

The Judges do not consider that there is a sufficiently wide margin of merit between the first and the bracketed second prizes to justify the full award of £20 for the first prize, and have, therefore, reduced the amount to £15, in order to provide two second prizes of £5 each.

In awarding the first prize to E. L. Clinch's designs (Nos. 2090 and 2091), the Judges have had more regard for the finished design than pictorial draughtsmanship. The sideboard shows good proportion and useful arrangement, the chairs have

pleasing proportions and shapes and the restrained character of all the designs is to be encouraged.

With regard to designs Nos. 1195 and 1196 by A. R. Liddicoat, and Nos. 1727 and 1728 by G. Stirling, which the Judges consider should be bracketed together for second prizes, they have specially considered the practical and useful character of the designs and have borne in mind that both sets of designs lend themselves to economic production.

SUB-SECTION 4 (*a*). *Prize offered by Venesta, Ltd., for a Design for a Plywood or Plymax (metal-faced plywood) Wireless Cabinet.*

The awards are as follows :—

A Prize of £5 to Philip Evans Palmer, 19, Handside Lane, Welwyn Garden City. (No. 1743).

Commended :

George Francis Bungay, 16, Hardenwaye, Totteridge, High Wycombe, Bucks. (No. 995).

SUB-SECTION 4 (*b*). *Prize offered by Venesta, Ltd., for a Design for a Plywood Sideboard.*

The awards are as follows :—

A Prize of £10 to George Francis Bungay, 16, Hardenwaye, Totteridge, High Wycombe, Bucks. (No. 996).

Highly Commended :

Eugene Welch, 40, Christ Church Gardens, Lichfield, Staffs. (No. 1772).

Commended :

Thomas Lees, 5, Russell Cottages, Broadway, Worcs. (No. 260).

SUB-SECTION 4 (*c*). *Prize offered by Venesta, Ltd., for a Design for a Plymax Sideboard or Desk.*

The awards are as follows :—

A Prize of £10 to William Henry Russell, c/o W. Stanley, Leamington Road, Broadway, Worcs. (No. 1695).

Highly Commended :

Eugene Welch, 40, Christ Church Gardens, Lichfield, Staffs. (No. 1773).

SUB-SECTION 4 (*d*). *Prize offered by Venesta, Ltd., for a Design for Interior Panel decoration of a Shoe Shop.*

The awards are as follows :—

A Prize of £15 to Don L. Milne Williamson, Sheffield College of Arts and Crafts. (Nos. 2913 to 2916).

Competitors in Sub-Section 4 were set a somewhat difficult task as the use of modern plywood in furniture has introduced new constructional problems which have not yet been finally solved, but have a direct and important bearing on design. It will be convenient to consider the four competitions in this Sub-Section together. The designs sent in are, on the whole, very creditable, and it is clear that some of the competitors have carefully studied the distinctive characteristics and limitations of the material. Designs Nos. 1742, 1743 and 1744, by Philip Evans Palmer, are happily conceived and satisfying in appearance. His sections, however, are open to criticism, the hinging of the doors in particular being unpractical. George F. Bungay's designs (Nos. 995 and 996) are logical and workmanlike. His construction has been well thought out, although the elaborate

perforated panel would be expensive to cut in Plymax. The decoration on his wireless cabinet is not altogether happy, but introduces a pleasing colour interest. Some attractive drawings are submitted by Eugene Welch (Nos. 1772, 1773 and 1774). His designs are effective and appropriate, but the Judges were unable to award him a prize as the Sections revealed an unsound method of construction. The use of plywood merely as a facing to solid wood is not economical or satisfactory. Design No. 1695, by W. H Russell, provides the most original and interesting treatment, the Plymax being used in conjunction with a steel framework. The introduction of metal into furniture construction has much to be said in its favour, and in the opinion of the Judges should be considered carefully and without prejudice. Mr Russell's design is, unfortunately, marred by a very commonplace treatment of the handles Of the designs sent in for the decoration of a shoe shop, No 2913, by Donald Milne Williamson, is the one which shows most imagination.

SUB-SECTION 5. *Prizes offered by Messrs J and T Scott for a set of two Designs for an Oak Combination Mantel for a Dining Room and a Mahogany Combination Mantel for a Drawing Room The wholesale cost of each Mantel not to exceed £10*

The awards are as follows

A Prize of £10 to Aubrey Percival Frederick Simms, 16, Evelyn Road, Newbridge Hill, Bath (Nos. 713 to 715).

A Prize of £5 to Frederick Charles Richter, Dromore, Dromore Road, Putney, S.W.15. (No 510).

The cost limit of £10 included in the conditions of this competition has naturally severely limited the competitors, and the small number of designs submitted may be partly due to this factor. The prize-winning designs in the opinion of the Judges show a commendable restraint in the use of ornament, and depend upon good proportion and simple treatment

SUB-SECTION 6 *Prize offered by the Star Manufacturing Company for a set of six Designs for Decoration of Side Panels of Baby Carriages*

The awards are as follows .—

A First Prize of £7 10s to Charles Henry Harnett, 114, Inverness Avenue, Westcliff, Southend-on-Sea, Essex. (No 1124)

A Second Prize of £2 10s. to Miss Gertrude Evelyn Cook, International Correspondence Schools, Ltd. (No. 1037d).

The Judges suggest that this competitor should give more attention to the practical aspects of this kind of manufacture

SUB-SECTION 7. *Prize offered by Messrs. William and H H James, Ltd, for Designs for Hat and Coat Hooks.*

Owing to the very limited number and poor quality of the designs submitted in this Sub-Section, the Judges were unable to make any award

SECTION IV.—BOOK PRODUCTION

SUB-SECTION 1. *A Title-page set from type with or without printers' ornaments.* [The book prescribed in each Sub-Section was "The Heart of Midlothian (Demy Octavo).]

The awards are as follows :-

A Prize of £5 5s. to David Chalmers Shand, London School of Printing and Kindred Trades. (No. 1558).

A Prize of £3 3s. to Bata Krishna Ray, London School of Printing and Kindred Trades. (No. 1716).

A Prize of £2 2s. to Ambrose Percival Pritchard, 111, Long Thornton Road, Norbury, S.W.16. (No. 1205).

Highly Commended :

Ambrose Percival Pritchard, 111, Long Thornton Road, Norbury, S.W.16. (No. 1207).

Bata Krishna Ray, London School of Printing and Kindred Trades. (No. 1717).

Peter Roberts, Hazell's Technical Institute. (No. 2115).

David Chalmers Shand, London School of Printing and Kindred Trades. (No. 1556).

Commended :

David Chalmers Shand, London School of Printing and Kindred Trades. (No. 1557).

It is to be regretted that the designs submitted in this Sub-Section do not equal the standard or number of last year.

Competitors seem to have been striving after novelty instead of considering the essentials of a title-page. Consideration should always be given to the choice and arrangement of type to obtain a dignified effect. Competitors should not submit the same designs in duplicate printed on different paper.

SUB-SECTION 2. *Three pages of text, set from type*

The awards are as follows :--

A Prize of £3 3s. to David Chalmers Shand, London School of Printing and Kindred Trades. (No. 1561).

A Prize of £2 2s. to Bata Krishna Ray, London School of Printing and Kindred Trades. (No. 1719).

Highly Commended :

Horatio Lister, 201, Toller Lane, Bradford., (No 2517).

William Reynolds, Heritage Arts and Crafts School. (No. 131 and No. 132).

David Chalmers Shand, London School of Printing and Kindred Trades (No. 1560).

The designs do not reach the standard or number of those submitted last year.

The attention of competitors is drawn to the need for their designs (three pages) to be mounted on one board. The same design should not be submitted in duplicate printed on different paper.

The Judges report that there is no outstanding feature in the work submitted. Competitors seem to have been content to copy accepted styles of work.

SUB-SECTION 3. *Line drawings in black and white, suitable for reproduction by line block or wood engraving of (a) a headpiece and (b) a tailpiece.*

The awards are as follows :--

A Prize of £3 3s. each to the following :—

Miss Violet Blair Irving, Liverpool City School of Art. (No. 3534).

John Yunge-Bateman, 26, Christchurch Road, Folkestone. (No. 1802).

Highly Commended :

Miss Nora Caroline C. Ivory, Liverpool City School of Art. (No. 3536).

SUB-SECTION 4. *A Design for an illustration in black and white suitable for reproduction by line block or wood engraving.*

The awards are as follows :—

A Prize of £3 3s. each to the following :—

Miss Gladys Muriel Archer, Liverpool City School of Art. (No. 3484).

Miss Ethel Nicholson, Hornsey School of Art. (No. 2293).

A Prize of £2 2s. to each of the following :—

Miss Berenice Butler, 34, Sutherland Place, Bayswater, W.2. (No. 287).

Eric Charles Vining, Leeds College of Art. (No. 2176).

Highly Commended :

George Maurice Alcock, International Correspondence Schools, Ltd. (No. 658 and No. 659).

Miss Eileen Maria Alderson, Sheffield College of Arts and Crafts. (No. 2871).

Commended :

Miss Berenice Butler, 34, Sutherland Place, Bayswater, W.2. (No. 286).

Miss Naomi Lang, Chelsea Polytechnic School of Art. (No. 255).

The general standard of the designs submitted in Sub-Sections 3 and 4 showed a marked advance on that of last year. Not only was the design better, but in nearly every case the artist has expressed the true atmosphere of the subject with considerable success. For all-round merit the Judges are of opinion that Miss Ethel Nicholson's Design No 2293 is worthy of special commendation for its striking technique and treatment. A strong note of originality is also shown in Miss G. M. Archer's Design No 3484

SUB-SECTION 5 *A case for a Binding in either cloth or leather.*

The Judges were unable to award any prize in this Sub-Section as they could find no merit or originality or feeling for design.

SUB-SECTION 6 *Designs for End papers*

The awards are as follows :—

A Prize of £5 5s to Miss Bertha Julia Olyett, Press Art School. (No. 1676 and No. 1677).

Highly Commended .

Miss Audrey Isobell McLaughlin, Royal College of Art. (No. 1538).

Commended :

Miss Nancy Allen Dixon, Liverpool City School of Art. (No. 3507).

Several quite good designs and ideas were submitted as applied to the special book prescribed, but those intended for general use were too similar to existing specimens to deserve recognition.

SUB-SECTION 7. *Designs for a Jacket.*

The awards are as follows :—

A Prize of £3 3s. each to the following . . .

Miss Joyce Hughlings Davies, Liverpool City School of Art. (No. 3502).

William Alfred Wright, L.C.C Putney School of Art. (No. 1749).

Highly Commended :

Percy Drake Brookshaw, Erith Technical College. (No. 2255).

Miss Faith Geraldine L. Gaskell, Battersea Polytechnic School of Art. (No. 1634).

Commended :

Miss Elsie M. Frostick, Battersea Polytechnic School of Art. (No. 2552 and No. 2553).

Some excellent work was submitted showing considerable originality and a good conception of the subject. Several competitors weakened the look of their lettering by putting a break in the word " Midlothian."

SECTION V.—POTTERY AND GLASS.

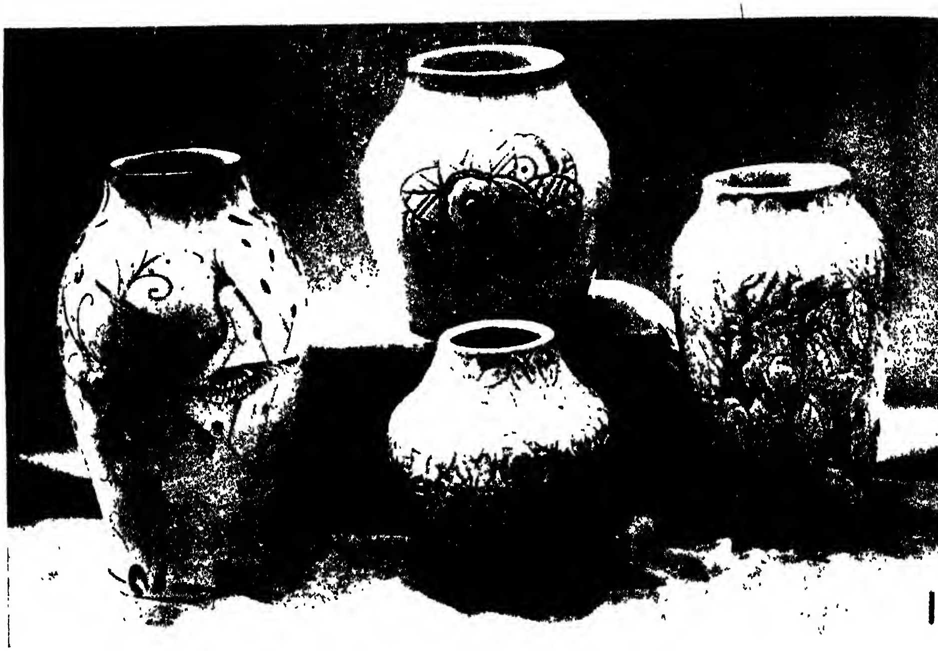
SUB-SECTION 1. (POTTERY). *An original decorated design executed in Pottery. Specimens to be fired, but the method of decoration, which was left to the competitor, could be either over or under glaze.*

The awards are as follows :

A Prize of £1 1s. each to the following :—

Joseph Bailey, Burslem School of Art. (No. 2605).

Miss Freda May Beardmore, Burslem School of Art (No. 2615 and No. 2616).



* Decorated designs in Pottery by C. E. Blackburn (Burslem School of Art), E. Owen (at the Stoke-on-Trent School of Art, and Miss F. Beardmore (Burslem School of Art)

Clarence Edward Blackburn, Burslem School of Art. (No. 2618).

Miss Ethel Norah Dawes, 3, The Headlands, Kettering. (No. 3324).

Miss Ursula Hamilton Kearne, Manchester School of Art (No. 3128).

Arthur Isaac Mattison, Stoke School of Art. (No 3253).

Eric Owen, Stoke School of Art. (No. 3255).

Miss Irene Pemberton, Burslem School of Art. (No. 2690 and No. 2691)

Miss Kathleen Penney, Manchester School of Art. (No. 3178).

Miss Beatrice Mary Potts, Burslem School of Art. (No. 2693).

Highly Commended :—

Joseph Bailey, Burslem School of Art. (No. 2604).

Miss Freda May Beardmore, Burslem School of Art. (No. 2617).

Clarence Edward Blackburn, Burslem School of Art. (No. 2619).

* Reproduced from *The Pottery Gazette*, September 2nd, 1929.

Miss Ellen Bridgwood, Burslem School of Art. (No. 2624).
Leonard Samuel Brookes, Burslem School of Art. (No. 2630).
Albert Coxon, Burslem School of Art. (No. 2637).
Cyril Stephen Lancaster, Burslem School of Art. (No. 2651).
Miss Muriel Linton, 37, St. Margarets Road, Oxford. (No. 3326).
Miss Emily May Mountford, Burslem School of Art. (No. 2685).
Miss Irene Pemberton, Burslem School of Art. (No. 2692).
Carl Rowley, Burslem School of Art. (No. 2697).

Commended :

Miss Irene Doris Barradell, L.C.C. Putney School of Art. (No. 3296).
Clarence Edward Blackburn, Burslem School of Art. (No. 2620).
Roy Stanley Durbar, Burslem School of Art. (No. 3356).
Miss Eliza Goucher, Burslem School of Art. (No. 2642).
Cyril Stephen Lancaster, Burslem School of Art. (No. 2652).
Eric Owen, Stoke School of Art. (No. 3258 and No. 3259).
Miss Irene Pemberton, Burslem School of Art. (No. 2688).
Miss Beatrice Mary Potts, Burslem School of Art. (No. 2694).
Carl Rowley, Burslem School of Art. (No. 2699).
John Shirley, Burslem School of Art. (No. 2708 and 2709).

This year the Committee departed from their former custom of prescribing designs only by asking for finished examples in Sub-Sections (1) and (2). The response has been extremely encouraging and more than justifies the new departure. Most of the works submitted were good plastic forms, simple and suitable for their purpose. Whilst recognising the difficulty experienced by some schools in producing the finished material, the Judges think it should be possible for these to co-operate with others more suitably provided with technical equipment.

Several pieces that were otherwise successful were "chancy" in their character, and these have not met with the same approval as the others. The *ensemble* has been taken into account, and simple ceramic processes have appealed to the Judges more than elaboration.

A number of competitors obtained shapes from local manufacturers, and these works were not so satisfactory as those entirely inspired by the students. Examples of this were various covered dishes and plates of such form as to suggest the inevitable type of decoration.

The Judges felt that the uniformity of merit in the first ten competitors was so great that it was impossible to discriminate amongst them, and they decided to divide the prize of £10 10s. equally amongst them. They were particularly pleased with two specimens from Manchester.

SUB-SECTION 2. (POTTERY). *An example of Modelling in Fired Pottery. The piece to be either ornamental or useful in character, and to take the form of figures, animals, baskets of flowers, etc., or of any article of domestic use.*

The awards are as follows :—

A Prize of £5 5s. and an Owen Jones Medal to Arthur Isaac Mattison, Stoke School of Art. (No. 3254).

A Prize of £1 1s. each to the following :—

Miss Nora Youle Crossland, Sheffield College of Arts & Crafts, on account of the thoroughness in the modelling. (No. 3624).

Miss Kathleen Goodwin, 5, Kingsfield Oval, Basford, Stoke-on-Trent. (No.

3276, No. 3277 and No. 3278).

Arthur Frederick Payne, 15H, Sutton Estate, Chelsea, S.W.3. (No. 3365, No. 3366 and No. 3367).

William Ruscoe, Stoke School of Art. (No. 3265).

John Empson Tindall, L.C.C. Central School of Arts & Crafts. (No. 3280).

Very Highly Commended :

John Empson Tindall, L.C.C. Central School of Arts. (No. 3279). The Judges appreciate the ability and ambition shown by this competitor.

Highly Commended :

Eric Owen, Stoke School of Art. (No. 3261).

Miss Jane Dobson Anderson Parkes, 108, West George Street, Glasgow. (No 3292).

* Models in Fired Pottery by Miss K. Goodwin (Stoke-on-Trent School of Art).

The prize-winning work was considered by the Judges to be outstanding in the qualities expected—modelling, decorative treatment and finish. Many of the smaller pieces showed a good plastic spirit.

A large and ambitious piece (No. 2,966,) whilst being fully appreciated, was considered to be somewhat outside the scope of this Sub-Section.

Sub-Section 3. (Pottery). *Design for a Plaque for wall decoration not exceeding 15in. in any dimension.*

* Reproduced from *The Pottery Gazette*, September 2nd, 1929.

The awards are as follows :—

A Prize of £1 1s. each to the following : —

Arthur Ewart Barnett, Burslem School of Art (No. 2613).
Eric Owen, Stoke School of Art. (No. 3271).
Miss Doris Parton, Hanley School of Art. (No 2726).

Highly Commended

Arthur Isaac Mattison, Stoke School of Art (No 3268).
William Ruscoe, Stoke School of Art. (No 3272, No. 3273 and No. 3274).
Miss Beatrice Anne Waldram, 3a, Downshire Hill, Hampstead, N.W.3. (No. 3289).

There was a general absence of sound design in this Sub-Section. The Judges were unable to select any outstanding work as most of the designs appeared to miss the spirit which it was desired to encourage. Many competitors failed by using unsuitable motives and hackneyed ideas. The works selected for approval were chosen because they showed either an appreciation of the modernistic tendencies or of a good traditional style. Twelve models in Pottery submitted for this Sub-Section had to be rejected as the specification distinctly mentioned " Designs only "

SUB-SECTION 4. (GLASS) *Designs for a Cocktail Glass and Shaker.*

The Judges were unable to recommend any prizes in this Sub-section, but the following award was made :

Commended :

Leonard Green, Wordsley School of Art. (No 2353 and No 2355).

The exhibits in general in this Sub.-Section are exceedingly disappointing, being unique in their lack of originality both in form and decoration. Not one single piece shows any enterprise at all in either outline or decorative treatment, one thing being evident that all the competitors dash off these drawings quickly and without any thought of the object for which this competition is intended, namely, to produce some pleasing production in keeping both in style, decoration and proportion with the best artistic productions of the present day. Any one of these designs might have come out of any mid-Victorian catalogue, had they made cocktails in that era, or out of any of the many brochures that come across from the Continent. Nos 2355 and 2353 are the two better designs of the four designs submitted by Leonard Green, and these only are to be commended. It is suggested to this competitor that on another occasion four times the thought should be put into one design, and one design only submitted instead of four. The submission of many designs by one competitor rather suggests that the competitor himself either cannot make up his mind as to what is right or wrong or that he has very little confidence in the designs he produces. Design No 2366, by R. Wilkinson is the only one which shows any departure from custom Any of the others might conceivably be ordinary spun model Cocktail Shakers as far as their form is concerned. This competitor has decided to affix a handle, making a stoppered jug serve the purpose of a Cocktail Shaker. His reason for doing so must be either (*a*) for use, or (*b*) as a piece of ornament. As a piece of ornament it fails badly, and in use it is not only unnecessary, but inconvenient In the first place, the handle must not be held when shaking, and, therefore, the handle makes it difficult to hold the bottle and stopper when performing this operation ; moreover, ice is a necessary ingredient of the cocktail, and when shaken inside a glass vessel, gives

sufficient strain on the material without adding a glass handle to it. This is a very risky part of the vessel at the best of times, and it may be doubted whether the handle would remain intact for any period of time. Nos. 2364 (C. L. Price) and Nos. 2353 and 2356 (L. Green), are to be criticised on account of the size and capacity of their glasses ; No. 2364 is hopelessly small, being hardly any larger in capacity than that of a liqueur glass. This rather suggests that these competitors have not troubled to ascertain what constitutes a Cocktail, as the holding capacity of any glass is one of its first essentials.

In general, all the designs give one the impression that all the competitors are so steeped in mitre cuts and hollows with all the stereotyped variations of the past 50 years or so that they have not applied themselves to think out any modern applications of this very old art, or even troubled to study some of the very charming applications so admirably conceived and beautifully executed in the 18th and 19th centuries.

SUB-SECTION 5. (GLASS). *Prize offered by Messrs. John Walsh Walsh, Ltd., for a design for a modern form of indirect Table or Pedestal Illumination suitable for electric light.*

The awards are as follows :—

The Prize of £10 10s. to John Empson Tindall, L.C.C. Central School of Arts & Crafts. (No. 3287).

Highly Commended :

John Empson Tindall, L.C.C. Central School of Arts & Crafts. (No. 3284, No. 3285, No. 3286 and No. 3288).

In this Sub-Section no designs, with the exception of those produced by J. E. Tindall, conform to the conditions. The remainder, with the exception of the Indian exhibits, are just Victorian cut-glass lamps The submission of these designs supports the criticism given on the previous Sub-Section, in that the general impression given by these designs is that the competitors have not given sufficient thought to their production ; otherwise, *directly* illuminated cut-glass lamps would not be submitted as designs of modern form for *indirect* table or pedestal illumination. The Indian exhibits are interesting, and it is felt that they deserve very definite encouragement. The particular designs in question fail, but not in the same way as those previously mentioned, as the Indian candidate does not appreciate the working limitations or constructional values of the material for which he is designing. Unfortunately, this is a fault over which they have very little control, and it is suggested that on another occasion, failing their ability to visit an actual glass works, they should obtain as many textbooks as are available in the public libraries on the question and, after studying them carefully, then decide as to whether they intend to treat the subject as Blown Hollow-Ware produced by hand, or as a pressed or moulded article. Having made this decision, further thought should be given to the factory production of the particular article for which they are designing, and they could then tackle the subject with some knowledge (superficial though it may be) how the article is to be produced. It must be remembered that glass is not cast and cannot be run from crucibles in the same way as any of the common or finer metals. Glass, in its working condition, is a treacly substance which can be either gathered on the end of a hollow tube (in which case it is generally formed into a blown hollow article), or, secondly, it can be taken from the furnace on a solid rod or in a ladle (or by any of the automatic methods described in the available textbooks on glass technology), and then

placed into moulds or dies and pressed into shape, the main thing in both cases to remember is that the glass article in question has a very short working range and becomes brittle, losing its viscosity at temperatures as high as 500 to 600 degrees centigrade, and that an annealing process follows immediately on the production process. In the case of pressed glass, moulds must be kept well below the setting temperature of glass; otherwise the glass article will stick to them, and the glass article must leave the mould before it becomes too cold to be brittle; otherwise it would become chilled and would crack before it reaches the annealing process. It is therefore impossible to do any false coring or very much undercutting in the design; otherwise it would be impossible to get a hot article quickly out of the mould. These later remarks apply to some extent to J. E. Tindall's exhibits. No. 3287 is the best from the point of view of construction in design and practical utility, and presents the least difficulty to the manufacturer in making. The idea has distinct and definite merit, and although the general outline of the figures below the main column does not conform with the main block as it should do in theory, very little alteration in this respect would make this a very pleasing piece. Nos. 3284/5 conform more closely to the specification laid down in the schedule, in that they are more truly indirect lighting, but the combination of hollow pedestal with solid figures in one piece of glass is impracticable in manufacture. This applies also, though not so forcibly, to the arms and lanterns in design No. 3284. In No. 3288 the Stand and its detail do not follow out the principle laid down in its main outline. The method adopted, also, to support the figure in the centre is also very impracticable from the point of view of utility. No. 3286 is pleasant and of good composition, but lacking in originality in comparison with Nos. 3284/5, and in constructional strength with the winning design. Nevertheless, it is quite a pleasant subject well treated and with restraint, giving the impression that the artist is working well within his limits. The Judges would suggest that the base of this piece should be re-designed, having regard to the fact that the base has to stand firmly and should give the impression of solidity; it is very doubtful whether this would be the case when the necessary lighting fittings had been inserted in this design. J. E. Tindall's designs are the only ones in this Section which merit an award, but had he confined himself to one or two designs at the outside, and supplemented them with the working drawings of how the moulds in question were to be made, his designs would have carried far greater weight, and many of their small defects would have presented themselves to the designer before the drawings were submitted.

SECTION VI.—ADVERTISING

POSTERS.

SUB-SECTION 1. *Prize offered by the Blackpool Corporation Advertising Committee for a Design for a Poster to advertise Blackpool as a Seaside Resort.*

The Judges were unable to recommend that the full prize of £25 should be given, but the following awards were made:

A First Prize of £15 to Sidney Vincent Dimond, Camberwell School of Arts and Crafts. (No. 2012).

A Second Prize of £10 to Arthur Leslie Butler, 25, Sutherland Place, Bayswater, W.2. (No. 373).

Commended:

John Dixon, Bradford College of Art. (No. 2513).
John Pinkney Gowland, 137, Boundary Road, Woking, Surrey. (No. 2934)
Thomas Hancock, 507, North Road, Darlington. (No. 70).

Miss Mary Jocelyn Hughes, St. Martin's School of Art. (No. 1655).

None of the designs seemed to be sufficiently outstanding to warrant the award of the whole prize of £25, but the two prize-winning designs have real merit. The design of S. V. Dimond (No. 2012) shows originality, while the design of A. L. Butler (No. 373) is well executed. The design of Cecil Cooke (No. 671), while not quite effective as a poster, would make a good newspaper cartoon.

SUB-SECTION 2. *Prize offered by the British Poster Advertising Association for a Design for a Poster to advertise the advantages of Poster Publicity.*

The awards are as follows :—

The Prize of £50 was awarded to William Hobson, 29, Farm Hill Square, Meanwood, Leeds. (No. 80).

Highly Commended :

Sydney Durant Banks, Northampton School of Arts and Crafts. (No. 239).
Arthur Leslie Butler, 25, Sutherland Place, Bayswater, W.2. (No. 374).
Wilfred Walker, 17, Walker Street, York. (No. 591)
William Bisset Wyllie, 131, Blenheim Place, Aberdeen (No 582).

Commended :

Leonard Grosvenor Stanley, The Bungalow, Gorway Road, Walsall (No 2499).

The designs submitted in this Sub-Section numbered 89, and in the opinion of the Judges the general standard was quite good. The prize-winning design " told the story " with force and simplicity. A. L. Butler's design (No. 374) is a striking and effective sketch, but one that would probably lose a great deal when enlarged to 16-sheet size. W. Walker's design (No. 591) is strong in conception and well carried out, but would have been improved by better lettering. S. D. Bank's design (No. 239) shows an effective modern treatment, but would be more suitable as a showcard. Many of the designs submitted " missed the point " and would have served equally well as advertisements for cocoa or custard powder ; others, whilst good as showcards, were quite unsuitable for use as posters. Many designs were spoilt by (*a*) indifferent lettering and (*b*) too much lettering. Competitors should remember that a poster must tell its story at a glance and that the phrase or slogan should be as brief as possible.

SUB-SECTION 3. *Prize offered by the British Commercial Gas Association for a Design for a Poster advertising Gas.*

The Judges, while recognising that the problem of representing gas as a source of light, heat and power is a difficult one, did not feel that any of the designs submitted was worthy of the award of the full prize of 50 guineas. They recommended, however, that the following awards be made :—

A Prize of £10 10s. each to the following :—

Miss Rosamond Curtis, Slade School of Art. (No. 216).
Robert Woodnorth, 21, Duke Street, Whitehaven. (No. 1283).

Commended :

Stanley Henry Burman, Willesden Polytechnic Art School. (No. 998).
David Macdonald Cameron, British and Dominions School of Drawing, Ltd. (No. 16).
Frederick James Joseph Dean, East Ham Technical College. (No. 1620).
Harold Hemingway, Rochdale School of Art. (No. 2829).
Walter Pritchard, Dundee School of Art. (No. 1980).
Hector Alexander Stewart, Homestead, Bearsden, Glasgow. (No. 1562).

SUB-SECTION 4. *Prize offered by Messrs. Henley's Tyre and Rubber Co., Ltd., for a Design for a Poster advertising the Company's Golf Balls.*

The Judges were unable to recommend that the full prize of £50 should be given, but the following awards were made :—

A Prize of £10 10s. to Alfred Edward Sergent, Leyton School of Art. (No 951).

A Prize of £5 5s. to John Joseph Nesbit, 37, London Road, Leicester. (No. 1197).

Highly Commended :

Ernest Morley Blatchford, Bournemouth School of Art (No 2731).

Commended :

Charles Dean, Liverpool City School of Art. (No. 3504).

John Pinkney Gowland, 137, Boundary Road, Woking, Surrey. (No 2930).

Elcon Hirsch, Regent Street Polytechnic School of Art (No. 3619).

While they recognise that the subject is a difficult one to handle, the Judges regret that the designs in general show little initiative or recognition of the essentials required in advertising--simplicity and directness. Students should be encouraged to study the requirements of the firms for whom they are designing. In this competition few competitors have appreciated the " selling points " of a golf ball.

Designs Nos 951 and 1197 are, however, meritorious and have been awarded prizes.

SUB-SECTION 5. *Prize offered by Messrs. Hugon and Co, Ltd, for a Design for a Poster advertising " Atora " Shredded Beef Suet.*

The Judges were unable to recommend that the full Prize of £50 should be given, but the following awards were made :-

A First Prize of £25 to Thomas John Fry, 34, Egham Road, Plaistow, E.13. (No. 1389).

A Second Prize of £10 to Harold Thornton, Burnley School of Arts and Crafts. (No. 959).

The general standard of the designs was poor. Many of them were conceived in terms of booklet covers rather than posters H Thornton's design (No. 959) showed a high standard of lettering and good balance Several designs omitted the fact that Atora is *beef* suet, which is the most important selling point in the whole campaign.

SUB-SECTION 6. *Prize offered by Motorways, Ltd, for a Design for a Poster describing their Motor Pullman Tours.*

The Judges were unable to recommend that the Prize of 25 guineas should be given, but the following awards were made :—

Commended :

Philip Hepworth, Leeds College of Art. (No. 2164)

Oswald Stanhope, Black and White Studios, Bedford Street, W.C.2. (No 947)

Cyril Francis Webber, Goldsmiths' College School of Art. (No. 962).

The general standard of this Sub-Section was low and showed a great lack of originality of thought.

No design was thought worth the expense of reproduction. One was a flagrant example of plagiarism from the Chrysler advertising.

The general design, lay-out, and lettering were poor ; nor had economy of reproduction been studied, with one exception, and in this case the student forgot entirely that he was advertising a Motor Coach Service.

Three designs were commended because there was some pretension to technical skill and also on account of their " sunny atmosphere."

SUB-SECTION 7. *Prizes offered by the Orient Line for a Design for a Poster advertising the Orient Line Mail Steamers to Australia.*

The awards are as follows :—

The First Prize of £30 to Percival Albert Trompf, 501, Little Collins Street, Melbourne, C.1., Victoria, Australia. (No. 2000).

The Second Prize of £10 to Basil White Ridley, Talboys, Broadham Green, Oxted, Surrey. (No. 1862)

Highly Commended :

Miss Winifred Amy Pringle Forgan, L.C.C. Central School of Arts and Crafts. (No. 340).

Arthur Edward Morrison, Liverpool City School of Art. (No. 3544).

Alfred Gordon Randall, 12, Manor Way, Uxbridge, Middlesex. (No 1265).

Clifford Rumney, 41, Burghley Road, St. Andrew's Park, Bristol. (No. 704).

George F. Yarnell, 450, Upper Richmond Road, Richmond, Surrey (No. 1313).

Commended :

Frederick Brian Hayes, Bath School of Art. (No. 1419).

Arthur Edward Morrison, Liverpool City School of Art. (No. 3545).

The entries are very encouraging, both in number and quality. They depend more upon their subject matter and their design than upon slogans. Strangely few are based upon catchwords, although one or two bills, such as No. 704 (C. Rumney) and No. 3515 (E. Fancott) are commendable in this way. Several attractive designs demand an expensive number of printings to attain their proper colour effect and this should perhaps have been more clearly borne in mind by the designers.

Perhaps the commonest failing of all has been the inability to eliminate detail. As a result lettering is often swamped by superfluous abstractions and promising colours drowned by others.

Several bills of the pure design type are successful and others depending upon simple lettering and colour are also pleasing, *e.g.*, No. 3545 (A. E. Morrison).

An interesting sidelight on the competition was the apparent difficulty of adapting the kangaroo to decorative purpose, or, indeed, of drawing it at all.

Several bills were rejected as they contained no lettering, and the Judges did not consider they could fairly compete with bills designed as a complete poster, with appropriate lettering.

In awarding the First Prize, the Judges felt that a vivid impression without too lavish a colour scheme, but telling its story in a very direct way, holds its own among more extravagant competitors. The second place was allotted to a symmetrical design using the ship as a focus of interest without any attempt at photographic representation Both of these in entirely different ways, the Judges considered extremely effective. Their eventual choice was only made after prolonged consideration.

SUB-SECTION 8. *Prize offered by the Prudential Assurance Company, Ltd., for a Design for a Poster advertising Insurance in general, and that Company in particular.*

The Judges were unable to recommend that the full prize of 25 guineas should be given, but the following awards were made :—

A Prize of £5 5s. to John James Heath, Keighley School of Art and Crafts. (No. 2147).

Commended :

William Blamire, 35, Eskdaill Street, Kettering. (No. 199).

Arthur Jack Cooper, 64, Grove Avenue, Twickenham. (No. 1582).

SUB-SECTION 9. *Prizes offered by Messrs. Simpson and Godlee, Ltd., for a Design for a Poster advertising "Essangee Unfadable Prints."*

The awards are as follows :

The First Prize of Thirty Guineas and an Owen Jones Medal to Miss Christina Forsyth, Edinburgh College of Art. (No. 3422).

The Second Prize of Twenty Guineas to Miss Adeline Mary Constance Hone, Leeds College of Art. (No 2166).

Highly Commended :

Miss Margaret Marion Ransford Cawood, Arden, Cornwall Road, Harrogate. (No. 434).

Miss Phyllis Gordon Dunlop, Leeds College of Art. (No. 2157).

Harold Hemingway, Rochdale School of Art. (No 2824).

Commended :

Miss Faith Geraldine Leycester Gaskell, Battersea Polytechnic School of Art. (No. 1628).

Miss Joan Horton, 20, South Hill Park Gardens, N W 3. (No. 1909).

Miss Marie Kale, Rochdale School of Art. (No 2845)

Miss Stella Frances Ogle, Leeds College of Art. (No 2171).

William Bisset Wyllie, 131, Blenheim Place, Aberdeen. (No 587).

On the whole there appeared to be too much tendency to play down to the intellect of the commercial man, and too much plagiarism

In these days of improved advertising it was remarkable that there was so much bad lay-out and bad lettering. There was, however, a big gap between the mass of the work submitted and a small group of excellent designs, which were technically good and quite fit for their purpose.

SHOWCARDS.

SUB-SECTION 10. *Prize offered by Messrs. Carreras, Ltd., for a Design for a Cut-out Showcard suitable for their Turf Cigarettes.*

The Judges were unable to recommend that the full Prize of 25 guineas should be given, but the following awards were made :—

A Prize of £5 5s. to John Fitzgerald Lawrie, Bournemouth School of Art. (No. 2739).

Commended :

George Archibald Frank Austen, Dover School of Art (No. 3338).

SUB-SECTION 11. *Prizes offered by Messrs. J. S. Fry and Sons, Ltd, for Designs for Showcards advertising (a) Fry's Carlets, (b) Fry's Cream Tablets.*

(*a*) The awards were as follows :—

The First Prize of £15 15s. to George Frederick Lunt, Liverpool City School of Art. (No. 3542).

The Second Prize of £7 7s to Leonard Towers, Liverpool City School of Art. (No. 3580).

Commended :

Miss Margaret Eleanor Hinckliett, Nottingham School of Art. (No. 3003)

Roy McLachlan, Rochdale School of Art. (No. 692).

(*b*) The awards were as follows :—

The First Prize of £15 15s. to Harry Turner, Halifax School of Art. (No. 2598).

The Second Prize of £7 7s. to Edmund William Green, Croydon School of Art. (No. 879).

Commended :

Miss Lily Evelyn Garrard, Ipswich School of Art. (No. 2134).

The entries as a whole are disappointing. Many of the competitors fail to realise that a strong and attractive design is far more important than a punning caption. When the endeavour is to make a pictorial joke the designs are liable to become mere illustrations. The most successful showcards are those in which a bright and decorative arrangement has been made out of the tablets or the "cartets" themselves. It should be remembered that simplicity and clarity has great value in a crowded sweet shop window. George F. Lunt achieved a very pleasant and bright design by very simple means in No. 3542, while No. 2598 (H. Turner), although rather thin in colour, has been awarded the first prize in (*b*) because of its simplicity and its good use of white space.

SUB-SECTION 12 *Prize offered by Messrs. W. T. Henley's Telegraph Works Co., Ltd., for a Design to advertise the Henley Wiring System.*

The Judges were unable to recommend that the full Prize of £25 should be given, but the following awards were made :--

A Prize of £10 to Roderick Melrose Clark, Liverpool City School of Art. (No. 3497).

Commended :

William Blamire, 35, Eskdaill Street, Kettering. (No. 201).

Roderick Melrose Clark, Liverpool City School of Art. (No. 3498).

Peter Thomas Alfred Roberson, City of Oxford School of Arts and Crafts (No. 2307).

Leonard Towers, Liverpool City School of Art (No. 3581).

None of the designs submitted for competition are considered suitable for the purpose. No. 3497 (R. M Clark) comes nearest to the required standard. This design, together with No. 3581 (L. Towers), No 2307 (P T. A. Roberson), No. 3498 (R. M. Clark) and No 201 (W. Blamire), show a good standard of draughtsmanship.

SUB-SECTION 13. *Prizes offered by Messrs. Rowntree and Co., Ltd., for a Design for a Cut-out Showcard to advertise their "Tried Favourites"*

The Judges were unable to recommend that the full amount of prizes should be given, but the following awards were made :

A First Prize of £10 to Stanley Richard Simms, 33, Victoria Road, Kentish Town, N.W.1. (No 527).

A Second Prize of £5 to Norman Francais John Abrahams, Blackheath School of Art and Crafts (No 1356).

Commended :

Benjamin Ward Lawton, Nottingham School of Art. (No. 3008).

Harold Kenneth White, Blackheath School of Art and Crafts. (No. 1797).

Whilst the designs this year show greater thought than in previous years, sufficient attention has not been given to arrangement of colour schemes ; more regard might also have been paid to suggestions contained in the firm's current advertising. A number of the designs submitted have quite a spotty appearance, which is detrimental to good display. The Judges regret that the designs do not warrant the award of the full prize amounts offered, and have decided as above.

COVERS AND PRESS ADVERTISEMENTS.

SUB-SECTION 14. *Prize offered by the Brighton Corporation Publicity Committee for a Design suitable for the Cover of the Brighton Official Guide.*

The awards are as follows

The Prize of £10 to Arthur Leslie Butler, 25, Sutherland Place, Bayswater, W.2. (No 370)

Commended :

Miss Helen K Willows, Manchester School of Art (No 3245)

The Judges have awarded the prize to A L Butler's design (No 370), as showing the requirements of the Brighton Corporation Publicity Committee more than any of the other designs It depicts a view of Brighton in the background, suggests sunshine and a good class of visitors—three important points for this type of advertisement Miss H K Willows' design (No 3245,) is commended for its artistic qualities

COVERS AND PRESS ADVERTISEMENTS

SUB SECTION 15 *Prizes offered by Messrs Hodder and Stoughton for (a) a Design for a Catalogue Cover suitable for their Fiction List, and (b) a Design suitable for their Belles Lettres and Religious Works List*

(a) The awards are as follows

The Prize of £10 10s to Miss Margaret Doreen Browning, Belswains, New Dover Road, Canterbury Kent (No 859)

Commended

Miss Kathleen Mary Lawrence, Croydon School of Art (No 2065)

(b) The Judges were unable to recommend that the Prize of £10 10s should be given, but the following awards were made

Highly Commended ,

Miss Katie McDonald, L.C.C Central School of Arts and Crafts (No 1838).

William Carter Wade Halifax School of Art (No 2603)

Commended

Miss Daphne Victoria Barry, Battersea Polytechnic School of Art (No 2533).

The standard of work being of but a poor character the Judges were only able to give the full award in the Fiction List Sub-Section A number of the designs made no attempt to conform to the conditions laid down

SUB SECTION 16. *Prize offered by Messrs Hovis, Ltd , for a Design suitable for an Advertisement of Hovis Bread in the Press or for a small Poster or Showcard.*

The Judges were unable to recommend that the full Prize of £50 should be given, but the following awards were made

A Prize of £10 10s each to the following

Frederic Gradwell, 15, Blake Street, Bolton (No 679).

Peter Robertson, 1, Fernley Road, Mile End, Stockport (No. 938)

William Lewis Winney, Leyton School of Arts and Crafts (No. 1769).

In view of the amount of the prize offered the general standard of the work submitted was disappointing In making the awards the Judges kept in mind the provisions laid by the donors, namely

(*a*) A Loaf of Hovis Bread should appear in the design

(*b*) A strong home appeal should be made

Of the prize-winning designs, No 938 by Peter Robertson conforms best with these conditions. No 679 by Frederic Gradwell, as an advertisement in an illustrated paper, is infinitely superior in execution and draughtsmanship, but does not meet to the same extent the requirements of the above-mentioned conditions

The same remarks apply to W L. Winney's design (No 1769), in which the domestic appeal is not sufficiently emphasised.

SUB-SECTION 17. *Prize offered by Messrs. John Player and Sons for a Design for a Black and White Advertisement of Player's Navy Cut Cigarettes suitable for reproduction in the Press*

The Judges were unable to recommend that the full Prize of £50 should be given, but the following awards were made :

A First Prize of £10 10s. to Edward Bishop, L.C.C. Central School of Arts and Crafts. (No. 292 and No. 293)

A Second Prize of £5 5s. to Claude Gilbard, Clifton Arts Club. (No. 680, No. 681 and No. 682).

A Prize of £2 2s. to Thomas Molyneux Paul, 404, Finchley Road, N.W.2 (No. 1678).

Highly Commended :

James Reddoch, Liverpool City School of Art (No. 3564)

Christopher Cavania Sanders, Royal College of Art (No. 1933)

Commended :

George Francis Bungay, 16, Hardenwaye, Totteridge, High Wycombe, Bucks (No. 997).

Versatility was shown in the designs submitted in this Sub-Section, but having regard to the value of the prize offered, the general standard was not considered high enough to warrant the full award.

Many of the competitors did not take sufficient care to give effect to the main requirement of this competition, which was that the advertisement should be suitable for Press advertising. Some designs, although otherwise quite effective in treatment, were open to objection from the point of view of suitability to the product.

The Judges decided to award consolation prizes where particular merit was shown. The award in respect of the designs Nos. 680-682, by Claude Gilbard, was made for originality of treatment.

An admirable advertising idea, although not suitable for Messrs. John Player and Sons' purpose, was contained in T. M. Paul's design (No. 1678.)

LORRY BILL.

SUB-SECTION 18. *Prize offered by Shell-Mex, Ltd., for a Design for a Lorry Bill advertising Shell Lubricating Oil or Shell Petrol, or both.*

The awards are as follows :—

A Prize of £13 2s. 6d. each to the following :—

Kenneth Beeley, Sheffield College of Arts and Crafts. (No. 2875).

William Bisset Wyllie, 131, Blenheim Place, Aberdeen. (No. 588)

Commended :

James Browning, Battersea Polytechnic School of Art. (No. 2537).

Frederick James Joseph Dean, East Ham Technical College. (No. 1606).

Ralph Ramm, L.C.C. Central School of Arts and Crafts (No. 1866).

The Judges were disappointed with the general level of attainment as to 75 per cent. of the designs submitted. They were of opinion that there was insufficient originality of thought and too great a tendency to be influenced by the success of others.

Of the two prize-winning designs, No. 588, by W. B. Wyllie, appealed to all the Judges as having the most intrinsic interest, but the artist has exceeded the number of colours laid down and has used lettering which both detracted from the design and was difficult to read. No. 2875, by K. Beeley, showed considerable originality

and sound drawing, but was to some extent spoilt by an unnecessary slogan and the fact that the ducks appeared to be finishing their flight rather than starting it.

Calendars and Christmas Cards.

Sub-Section 19. *Prizes offered by Messrs. C. W. Faulkner and Co., Ltd., for (a) a Design for a Calendar and (b) a Design for a Christmas Card.*

(*a*) The Judges were unable to recommend that the full amount of prizes should be given, but the following awards were made

A Prize of £10 to Miss Joan Hoyle, 86, Oakfield Road, Cannon Hill, Birmingham. (No. 1136).

A Prize of £5 to Miss Marian Fielding Peck, Sheffield College of Arts and Crafts (No. 2808)

Commended.

Miss Adeline Mary Constance Hone, Leeds College of Art. (No. 2165).

John Bowyer Oakley, Heatherley School of Art (No 1200)

(*b*) The Judges were unable to recommend that the full amount of Prizes should be given, but the following awards were made -

A Prize of £7 10s. to Miss Winifred Jane Pearcey, Keighley School of Art and Crafts. (No 503).

A Prize of £5 to Miss Gwendoline Dolman, Sheffield College of Arts and Crafts. (No. 2919).

A Prize of £4 to Miss Florence Walker, Harrogate School of Art. (No 608),

Commended:

Miss Mary Mack, Cornwall, Canada. (No 111)

Miss Wendy Joyce Morel, Bickham Manor, Timberscombe, Taunton. (No 693).

A large proportion of the designs submitted, both under (*a*) and (*b*) showed too little consideration of the question of suitability for the purpose, nor was much originality displayed in this Sub-Section.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

Monday, November 4. Automobile Engineers, Institution of, at the Merchant Venturers' Technical College, Bristol. 6.45 p.m. Captain F. W. Johnson, "The Inspection of Metals and their Alloys."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Paris and the Pyrenees. Notes on some of the Technical Features of the I.E.E. 1929 Visit." Opened by Mr. R. Borlase Matthews. At the University, Liverpool. 7 p.m. Messrs. Johnstone Wright and C. W. Marshall, "The Construction of the 'Grid' Transmission System in Great Britain."

Engineers, Society of, at Burlington House, W. 6 p.m. Mr. Gerald A. Wright, "Land Drainage."

Farmers' Club, at the Whitehall Rooms, Hotel Metropole, Whitehall Place, S.W. 4 p.m. Prof. W. G. S. Adams, "The Progress and Work of Rural Community Councils."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. H. G. Watkins, "River Exploration in Labrador by Canoe and Dog Sledge."

Royal Institution, Albemarle Street, W. 5 p.m. General Meeting.

University of London, at Bedford College, Regent's Park, N.W. 5.30 p.m. Prof. P. Hazard, "Le Voyage et la Mentalité Française au XVIII Siècle." (Lecture I.)

At King's College, Strand, W.C. 5.30 p.m. Rev. G. E. Newsom, "The Church and the World. Lecture V.—The Passing of Medievalism."

At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music. Lecture I.—A Parish Concert."

At University College, Gower Street, W.C. 2 p.m. Prof. L. N. G. Filon, "England in Shakespeare's Day. Lecture IV. Cosmography in the 16th Century."

At University College, Gower Street, W.C. 5 p.m. Dr. R. J. Brocklehurst, "Secretion of the Digestive Juices." (Lecture IV.)

at University College, Gower Street, W.C. 5 p.m. Sir C. V. Raman, "Molecular Scattering of Light: Lecture 1. The Classical Theories and their Experimental Test."

At University College, Gower Street, W.C. 5.30 p.m. Prof. J. E. Neale, "The Elizabethan Parliament." (Lecture IV.)

Tuesday, November 5. Arts, Royal Academy of, Burlington House, W. 4.30 p.m. Prof. Arthur Thomson, F.R.C.S., "Anatomy—A Rapid Survey of the Main Features of the Upper Limb."

Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Dr. W. H.

Hatfield, "Automobile Steels" (Joint Meeting with the Iron and Steel Institute).

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. W. W. Grierson, Presidential Address.

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. The Right Hon Sir Hilton Young, "The East African Opportunity."

Television Society, at the Engineers' Club, Coventry Street, W. 8 p.m. Mr. F. Langford-Smith, "Amplification and Television."

University of London, at Bedford College, Regent's Park, N.W. 5.30 p.m. Prof. P. Hazard, "Le Voyage et la Mentalité Française au XVIII Siècle." (Lecture II.)

At King's College, Strand, W.C. 5 p.m. Dr. J. W. Pickering, "Blood Plasma and Platelets." (Lecture V.)

At King's College, Strand, W.C. 5.30 p.m. Mrs. N. A. Duddington, "Russian Philosophy at the Present Time."

At King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1801. Lecture IV. Western Neighbours. Novgorod."

King's College (at 10 Torrington Square, W.C.), 5.30 p.m. Dr. J. Krzyzanowski, "The Polish Novel in the 19th Century. Lecture III. Boleslas Prus and the Social Novel."

At the London School of Economics, Houghton Street, W.C. 5 p.m. Dr. M. Ginsberg, "The Contribution of Prof. Hobhouse to Philosophy and Sociology."

at University College, Gower Street, W.C. 5 p.m. Sir C. V. Raman, "Molecular Scattering of Light. Lecture II.—New Paths in Molecular Optics."

Zoological Society, Regent's Park, N.W. 5.30 p.m. Scientific Business Meeting.

WEDNESDAY, NOVEMBER 6. Analysts, Society of Public, at Burlington House, W. 8 p.m. (1) Messrs. E. R. Bolton and K. A. Williams, "The Grouping of Fatty Oils, with Special Reference to Olive Oil." (2) Dr. Cuthbert Dukes, "The Heat Resistance Curve. A New Bacteriological Test for Pasteurised Food." (3) Messrs. W. R. Mummery, and F. Bishop, "A New Borax Solubility Test for Lactic Acid or Natural Sour Casein."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Captain C. F. Kennedy-Purvis, R.N. (Chairman of the Wireless Section), Inaugural Address.

Geological Society, Burlington House, W. 5.30 p.m. (1) Dr. H. Bolton, "Fossil Insects of the South Wales Coalfield." (2) Major A. R. Dwerryhouse, D.Sc., and Mr. A. A. Miller, "The Glaciation of Clun Forest, Radnor Forest, and some Adjoining Districts."

Heating and Ventilating Engineers, Institution of, at 29 Hart Street, Bloomsbury, W.C. 7 p.m. Mr. R. Grierson, "Notes on Electric Warming, with special reference to Low Temperature Panel Systems."

North East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-upon-Tyne. 7.15 p.m. Address by Mr. H. A. Morham, Chairman of Graduate's Section.

Public Health, Royal Institute of, 37 Russell Square, W.C. 4 p.m. Dr. Stanford Cade, "The Possibilities and Limitations of Radium Treatment."

University of London, at Bedford College, Regent's Park, N.W. 5.30 p.m. Prof. P. Hazard, "Le Voyage et la Mentalité Française au XVIII Siècle." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Dr. F. A. P. Aveling, "Personalism: A Psychological Approach to Reality. Lecture V.—The Approach to Transcendental Reality."

At King's College, Strand, W.C. 5.30 p.m. Prof. D. M. Blair, "The Contribution of King's College to the Advancement of Learning during the Century 1829–1929. Lecture V. Medical Science."

At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture V on "Office Machinery."

At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Lirica del Paradiso." (Lecture I).

At University College, Gower Street, W.C. 5.30 p.m. Mr. I. C. Gröndáhl, "Some Norwegian Writers of the Present Day (Riksmaal)." (Lecture I.)

At the Royal Veterinary College, Great College Street, N.W. 5.30 p.m. Major G. W. Dunkin, "Recent Researches on Immunization against Distemper in the Dog." (Lecture I).

THURSDAY, NOVEMBER 7. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Dr. A. E. Dunstan, "Recent Developments of Fuels and Dopes for Aircraft Engines."

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. F. Challenger, C. Higginbottom and A. Huntington, "The Nitration of Aromatic Thiocyanates." (2) Messrs. F. Challenger and A. D. Ainley, "Studies of the Boron-carbon Linkage. Part I. The Oxidation and Nitration of Phenylboric Acid."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. B. A. G. Churcher and A. J. King, "The Analysis and Measurement of the Noise emitted by Machinery."

Electrical Association for Women, at Messrs. Shoolbred Ltd., Tottenham Court Road, W. Mr. W. J. Jones, "Electric Light and Eye-Sight Preservation."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C., The Geffrye Museum, Kingsland Road, E. [illegible] p.m. Sir Charles Allom, "The Restoration of an Ancient Castle to Modern Use."

University of London, at Bedford College for Women, Regent's Park, N.W. 1.30 p.m. Prof. [illegible], "Montaigne" (in French). Lecture V.

At King's College, Strand, W.C. 5 p.m. Mr. C. J. Gadd, "The Babylonian Background of the Captivity."

At King's College, Strand, W.C. 5 p.m. Dr. J. A. Hewitt, "Metabolism of the Carbohydrates and Fat." (Lecture IV.)

At King's College, Strand, W.C. 5.30 p.m. Mr. H. W. Steed, "The Minorities Question and the Union of Europe. Lecture IV. A United States of Europe."

At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. L. Robbins, "The Present Position of Economic Science."

at University College, Gower Street, W.C. 5 p.m. Sir C. V. Raman, "Molecular Scattering of Light. Lecture III. Light Scattering and the Quantum Theory."

At University College, Gower Street, W.C. 5.30 p.m. Rt. Hon. Viscount Grey of Fallodon, "Natural History: the Pleasure and Purpose of Observation."

At the Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Sir L. Weaver, "English Lead Work."

FRIDAY, NOVEMBER 8. Astronomical Society, Burlington House, W. 5 p.m.

Asiatic Society, at Burlington House, W. 5 p.m. Sir Aurel Stein, "Alexander's Campaigns on the North-West Frontier of India." (Joint Meeting with the Central Asian Society.)

Illuminating Engineering Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Mr. W. S. Stiles, "The Nature and Effects of Glare."

Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Annual General Meeting.

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Metals, Institute of, at the University, Sheffield. [illegible] p.m. Mr. F. Orme, "Nickel-Silver."

Oil and Colour Chemists' Association, at Liverpool. 7 p.m. Dr. Fox, O.B.E., "Some Reminiscences of a Government Laboratory."

Physical Society, at the Imperial College of Science and Technology, Imperial Institute Road, S.W. 5 p.m. Prof. Sir C. V. Raman, F.R.S., "Diamagnetism and Molecular Structure."

University of London, at King's College, Strand, W.C. 5.30 p.m. Monsieur Benjamin Crémieux, "The French Novel. Lecture III.—Balzac."

At King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture IV. Ostrovsky."

At King's College for Household and Social Science, Campden Hill Road, W. 5 p.m. Prof. V. H. Mottram, "Human Nutrition." (Lecture IV.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. C. S. Elton, "The Future of Animal Ecology." (Lecture III.)

At University College, Gower Street, W.C. 5.30 p.m. Sir Richard Lodge, "English Parties and Foreign Policy in the Eighteenth Century." (Lecture II.)

SATURDAY, NOVEMBER 9. L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. John E. S. Dallas, "Wild Flowers in London's Open Spaces."

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FRIDAY, NOVEMBER 8th, 1929.

All communications for the Society should be addressed to the Secretary John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, NOVEMBER 13th, at 8 p.m. (Ordinary Meeting). J. O. BOVING, "New Developments in Hydraulic Pneumatic Engineering." CHARLES VERNON BOYS, F.R.S., will preside.

REPRINTS OF CANTOR AND SHAW LECTURES.

The three Cantor Lectures on "The Treatment of Coal," by Dr. C. H. Lander, C.B.E., M.Inst.C.E., M.I.Mech.E., and the three Shaw lectures on "Thirty Years' Experience of Industrial Maladies," by Sir Thomas Morison Legge, C.B.E., M.D., have been reprinted in pamphlet form (price 2s. 6*d.* each), and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can be had on application.

PRESERVATION OF ANCIENT COTTAGES.

WEST WYCOMBE

The *Journal* of March 22nd announced that the Council had agreed to purchase the Village of West Wycombe, Buckinghamshire, and since then a good deal has appeared in the public press in connection with this important transaction by the Society. Although there is no evidence yet of any restoration work, a great deal of preparatory work has been done, and it is hoped that in the New Year the Village will begin to take on an entirely new aspect. The Society realise their responsibility in undertaking this work, and have not yet

West Wycombe, Buckinghamshire

made any definite appeal to the County for financial assistance, as they felt it better to do this when they were in a position to start the work of restoration. They have, however, received a number of generous contributions to the fund, and they are very hopeful that the necessary amount to complete the purchase will be forthcoming when the booklet descriptive of their aims is issued. Her Majesty the Queen has shown her interest in the preservation of this Village by accepting an advance copy of the Appeal booklet and giving Her consent to this being formally announced. The American Ambassador has also accepted a copy and expressed his pleasure that there was an organised movement by the Society for protecting the engaging beauty of England. As he says, the preservation of West Wycombe saves for the future a fine picture of English life and history. The Haig Trust for Disabled Ex-Service Men has entered into a contract to take over the rather derelict block of cottages on the left as you enter the village, to spend a considerable sum in remodelling these from within, and to build behind such additional cottages as they require for a little community group. No alteration will be made to the external appearance of the cottages without the consent of the Society's advisers. This work would have been started by now but the Haig Trustees stipulated that they could not sign the contract without a definite undertaking that proper drainage facilities would be provided by the authorities. The Rural Council are negotiating with the Urban Council with this end in view, and it is hoped very shortly to be in a position to begin the work. The hotel and the two inns have two years to run before they come into the possession of the Society, but the Society's Agent is dealing with the question of dilapidations, and it is hoped soon to report when these will be reconditioned and made wholesome places for refreshment. There was one interesting house in the village which the Society were not able to acquire in the first instance, as Sir John Dashwood needed it for his Agent. As he is now able to provide accommodation elsewhere on his Estate, it was thought desirable to acquire this. The Society felt it needed some official centre in the village where information could be given as to its activities, and which might be a kind of guest-house. Through the generosity of Lady Binning, who has already been a liberal friend of the movement, this house has now been acquired and will be restored and made suitable for this purpose as soon as possible. It is a very characteristic Queen Anne house with a charming little garden.

The booklet will very shortly be available for all Fellows of the Society, and although it is addressed in particular to Buckinghamshire, it is hoped that the Fellows will endeavour to make the work and the Appeal as widely known as possible. The cost of the booklet will be defrayed by the sale of a number of copies autographed by the distinguished contributors. The Society feel that if they can succeed in giving new life to this little industrial village, it will have provided an object lesson which must have a lasting influence on the work of the preservation of England.

Arlington Row, Bibury, after restoration

ARLINGTON ROW, BIBURY.

The restoration work here is now practically completed. The Society has received gratifying reports from the locality that the work has been well done and is much appreciated. It was always realised that the amount contributed would hardly meet the necessities of this rather derelict group of cottages, and when the surrounding ground has been tidied up and the stream in front of the cottages cleaned up, there will be a sum of £325 still to find. It is proposed to put a tablet on a small building as one approaches the cottages, indicating that they were restored by the Royal Society of Arts. It is hoped that early in the New Year some formal handing over of the property may be arranged. Meantime, any further contributions for this work would be very gratefully received.

NOTES ON BOOKS.

THE COTTAGES OF ENGLAND. By Basil Oliver. London: B. T. Batsford, Ltd. 21s.

This is an excellent book, well written, fully illustrated, with no sentimental emphasis. It appears at a good moment, when civilised people of both conservative and, as it were, progressive temperaments are uniting to defend a lovely part of our heritage from the indifferent speculator. Mr. Stanley Baldwin in his preface, and the author in the Introduction, make it quite clear (to those who are not already aware of the fact, as they should be), that the preservers of rural England are animated by no mere passion for the antique, and that they are in no sense the heirs of that famous gentleman who wanted his architect to build him "an ornamental building which should have the appearance of a convent, be partly in ruins and yet contains some weatherproof apartments."

It is desired to preserve our old cottages from the weather as well as from the pick. Their variety and their value can be studied in Mr. Oliver's book; and what a wonderful assemblage of photographs this is! All the English counties are represented, and therefore, all the manners of construction; cottages of stone and brick, and cottages with half timber framework. The geological map, Fig. 1, drawn by Mr. Sydney Jones, explains the distribution of styles. It shows the oölitic belt within which our most interesting stone cottages are to be found; this stretches from a point in Lincolnshire south-west to the coast of Dorset. It marks the chalk and timber regions, the limestone and sandstone shires of the north, and the granite of Cornwall.

To have a taste for old cottages we need not first be lovers of the Gothic. To the lover of the Classical styles old cottages appeal because their scale is human and their execution so often broad and spontaneous. Carried out, moreover, in local materials, they are apt to harmonise with their environment; their tones fuse with the rest of the picture; at any rate, they thrill the painter in us. But not seldom the architect also is satisfied; look at Wareham and Bibury, Castle Combe, Groombridge and Dinder, where the cottages are interestingly grouped. The photograph of Wareham from the air suggests intelligent planning—something more than grouping, an effect which is enhanced by the clear cut aspect of the stone houses, individually and in blocks.

The character of our English cottages ranges from the simple masculine to the simple feminine; in between we get a pleasant type that combines strength with grace. Generally speaking, Cornwall and the north give us the virile sort of cottage,

half timber and thatch produce the more feminine feeling, while some of the tile-hung houses of Kent have a quiet sophistication which is not too much "hundred per cent." one way or the other.

The work of the Committee of the Royal Society of Arts is becoming widely known and as widely appreciated. What is wanted is everywhere a sense of local patriotism, so to speak; a sense that the people of every neighbourhood should make themselves as far as possible responsible for the preservation of the old cottages that yet remain for their delight. Certainly it is absurd to resist the builders' encroachments unless the cottages that already stand are habitable. There is no room for a negative policy.

Mr. Oliver's book, the facts and illustrations he provides, should make every reader feel keenly the importance of the question in its larger aspects, and should make people want to come together and pursue a definite policy, presenting a united front to the vandal and the materialist. The cottagers themselves have often a lively interest in the beautiful and curious homes in which they live, and they are thus able to develope an æsthetic sense which it is very hard to inculcate in towns-men, accustomed from earliest childhood to contemplating a vulgar environment without horror.

GENERAL NOTE.

THE NINETEENTH ENGLISHWOMAN EXHIBITION OF ARTS AND HANDICRAFTS.—The well-known annual Englishwoman Exhibition of Arts and Crafts will be opened at 12 noon on Wednesday, November 13th, at the Central Hall, Westminster, and will remain open until Saturday, November 23rd (11 a.m. to 7 p.m. each day) The Exhibition, which is under very influential patronage, will comprise exhibits of almost every description of arts and crafts, including jewellery, pottery, weaving, wood-carving, furniture, leather work, printing and book-binding, silver and metal work, lampshades, embroidery, lace, toys, enamelled glass and a large variety of other articles. There will be daily demonstrations in pottery making, weaving, lace-making and other craft work.

MEETINGS OF THE SOCIETY BEFORE CHRISTMAS.

ORDINARY MEETINGS.

Wednesday evenings, at 8 o'clock (unless otherwise announced).

NOVEMBER 6 (8.30 p.m.)—Opening Meeting of the One-hundred-and-seventy sixth Session. Inaugural Address by LLEWELYN B. ATKINSON, M.I.E.E., Chairman of the Council of the Society, on "Fifty Years of Electrical Science and Industry."

NOVEMBER 13.—J. O. BOVING, "New Developments in Hydraulic Pneumatic Engineering." CHARLES VERNON BOYS, F.R.S., will preside.

NOVEMBER 20.—P. MORLEY HORDER, F.S.A., "The Protection of Rural England."

NOVEMBER 27.—C. NORMAN KEMP, B.Sc., A.I.C., Secretary, Royal Scottish Society of Arts, "The Examination of Coal and Coke by X-Rays." (Dr. Mann Lecture). DR. FRANK S. SINNATT, F.I.C., M.I.Min.E., will preside.

DECEMBER 4.—HARRY H. PEACH, Hon. Secretary, Council for the Preservation of Rural England Exhibition Committee, "The Advertiser and the Disfigurement

of Town and Countryside: Criticisms and Suggestions." SIR LAWRENCE WEAVER, K.B.E., will preside.

DECEMBER 11.—MAJOR CHARLES WHEELER, O.B.E. (Mil.), M.I.A.E., formerly Chief Automobile Engineer of the General Post Office, "Overheads and other Factors influencing Road Transport Costs from an Engineer's Viewpoint." JOHN MAUGHFLING, C.A., will preside.

INDIAN SECTION.

Friday afternoons at 4.30 o'clock.

NOVEMBER 8.—A. M. GREEN, I.C.S., Acting Trade Commissioner for India, "The Indian Cinema Industry." DR. T. DRUMMOND SHIELS, M.C., M.P., Parliamentary Under-Secretary of State for India, will preside.

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

E. G. RICHARDSON, B.A., Ph.D., D.Sc. (Lecturer at University College), "Wind Instruments from Musical and Scientific Aspects." Three Lectures, November 18th, and 25th, December 2nd.

LECTURE I.—Sounds of pipes and methods of exciting them. Primitive pipes. The hydraulus and early organ pipes. The introduction of side holes. Precursors of the flute. Early reed pipes and reed instruments. The introduction of keys. Early brass instruments.

LECTURE II.—How the air is set in vibration in a flute and flue pipe. The formation of eddies. Edge-tones and their importance in the functioning of the flute. How a reed sets the air in vibration. The function of mouth pieces of brass instruments.

LECTURE III.—Effect of the shape, material and "scale" of the pipe. The modern flute. The clarinet, oboe and allied reed instruments. Brass instruments with pistons. The trombone.

Demonstrations will be given on the various instruments.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 11..Abattoir Society, Model, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Brig.-General Charteris, "The Provision and Control of Slaughterhouses." (Benjamin Ward Richardson Memorial Lecture).

Automobile Engineers, Institution of, at Queen's Hotel, Birmingham. 7 p.m. Dr W. H. Hatfield, "Steels for Automobiles and Aeroplanes."

East India Association, at Caxton Hall, Westminster, S.W. 1.30 p.m. Mr. Waris Ameer Ali, "Preservation of Indian Fauna."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Temporary Expedients in Engineering." Opened by Mr. W. G. Highfield.
At Armstrong College, Newcastle-on-Tyne. 7 p.m. Lt.-Col. S. E. Monkhouse and Mr. L. C. Grant, "The Heating of Buildings Electrically by means of Thermal Storage."
At the University, Edmund Street, Birmingham. 7 p.m.
At the Merchant Venturer's Technical College, Bristol.

Geographical Society, Lowther Lodge, Kensington Gore, S.W. 5 p.m. Papers on Stereographic Survey.

Heating and Ventilating Engineers, Institution of, at the Borough Polytechnic, Southwark, S.E. 7 p.m. Debate, "Panel versus Direct Heating."

Metals, Institute of, at 39 Elmbank Crescent, Glasgow. 7.30 p.m. Mr. George Mortimer, "Some Difficulties in Aluminium Alloy Founding and some Remedies."

Photographic Society, 35 Russell Square, W.C. 7 p.m. Meeting of the Kinematograph Group.

Surveyors' Institution, 12 Great George Street, S.W. 8 p.m. Mr. C. H. Bedells, Presidential Address.

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Annual General Meeting. Sir Henry Fowler, "Locomotive Repairs."

University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. G. E. Newsom, "The Church and the World. Lecture VI—The Modern Period."
At University College, Gower Street, W.C. 2 p.m. Mr. N. F. Hall, "England in Shakespeare's Day. Lecture V—Tudor Commerce and Industry."

TUESDAY, NOVEMBER 12..Automobile Engineers, Institution of, at the King's Head Hotel, Coventry. 7.30 p.m. Mr. J. Wallace, "The Super-Sports Motor Cycle."

Anthropological Institute, 52 Upper Bedford Place, W.C. 8.30 p.m. Mr. E. E. Evans-Pritchard, "Zande Witch-Doctors."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Mr. E. J. Evans, "Feed Heating by extracted Steam in Generating Stations." At the Engineers' Club, Manchester. 7 p.m. Mr. R. A. Chattock, "The Modern Use of Pulverized Fuel in Power Stations." (Joint Meeting with the Institution of Mechanical Engineers).
At the Royal Technical College, Glasgow. 7.30 p.m. Mr. G. Morgan, Chairman's Address.

Eugenics Society, at Burlington House, W. 8 p.m. Dr. C. P. Blacker and Dr. W. W. Herbert, "Insanity."

Marine Engineers, Institute of, 85-88 The Minories, E.C. 6.30 p.m. Mr. J. Harbottle, "The Opposed Piston Oil Engine."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Dr. Robert Hay, "Age Hardening in Alloys."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Lt.-Col. Sir Arnold T. Wilson, "Oil Legislation in Central and South America."

Quekett Microscopical Club, 11 Chandos Street, W. at 7.30 p.m. Mr. E. A. Robins, "Spiders; Notes on their Life and Habits."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1861. Lecture V—Rise of Moscow."
King's College (at 40 Torrington Square), W.C. 5.30 p.m. Dr. J. Krzyzanowski, "The Polish Novel in the 19th Century. Lecture IV—Boleslas Prus and his Philosophy."
At University College, Gower Street, W.C. 6.30 p.m. Mr. E. T. Elbourne, "Engineering Management." (Lecture I).

WEDNESDAY, NOVEMBER 13..Anthropological Institute, at the Portland Hall, Great Portland Street, W. 5.30 p.m. Sir A. Keith, "Race Building—Past and Present."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Rembrandt and his Pupils. (Illustrated by magnified photographs).

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Mr. R. Moreland, "Developments in Structural Iron and Steelwork during the past 50 Years."

Literature, Royal Society of, 2 Bloomsbury Square, W.C. 5 p.m. Mr. L. Housman, "The Spirit of Pre-Raphaelitism in Painting and Poetry."

Metals, Institute of, at Thomas's Cafe, High Street, Swansea. 7 p.m. Mr. W. E. Prytherch, "The Effect of some Impurities in Copper."

Public Health, Royal Institute of, 37 Russell Square, W.C. 4 p.m. Dame A. Louise McIlroy, M.D., D.Sc., "The Influence of Pathology upon Maternal Welfare",

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. E. Wilson, "The Contribution of King's College to the Advancement of Learning during the Century 1829-1928. Lecture VI—Engineering." At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture VI on "Office Machinery."

the Dog." (Lecture II).
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Mr. H. A. R. Gibb, "Ibn Battutah."
At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Lirica del Paradiso." (Lecture II).
At University College, Gower Street, W.C. 5.30 p.m. Mr. I. C. Gröndall, "Some Norwegian Writers of the Present Day (Riksmaal)." Lecture II.

THURSDAY, NOVEMBER 14..Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. A. Erskine, "The Economic Combustion of Coal."

Historical Society, 22 Russell Square, W.C. 5 p.m. Mr. G. H. White, "King Stephen's Fiscal Earldoms."

L.C.C., The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Stafford Ransome, "Wood-working Machi

Mechanical Engineers, Institution of, at the South Wales Institute of Engineers, Cardiff, 6.30 p.m. Address by Mr. H. D. Madden, Chairman of the Branch.

Metals, Institute of, at the Royal School of Mines, South Kensington, S.W. 7.30 p.m. Mr. H. Livingstone Sulman, "Mineral Flotation."
At the Chamber of Commerce, Birmingham. 7 p.m. Open Discussion on "Rolling."

North East Coast Institution of Engineers and Shipbuilders, at the Cleveland Institution, Middlesbrough. 7.30 p.m. Eng.-Captn. J. J. Sargent, "Notes on Practical Marine Engineering Problems."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Eccles, "Montaigne" (in French). Lecture VI.
At King's College, Strand, W.C. 5 p.m. Dr. W. Robson, "Protein Metabolism." (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Mr. I. L. Evans, "Austria in the Eighteenth Century." (Lecture I).
At King's College, Strand, W.C. 5.30 p.m. Prof. W. Ford, "Handel's Songs."
At King's College, Strand, W.C. 5.30 p.m. Col. C. G. Ling, "The Officers' Training Corps."
At King's College, Strand, W.C. 5.30 p.m. Dr. J. A. Williamson, "The Cabots and the Discovery of the New World." (Lecture I).
At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Momentous Law-suits and Trials in various Countries from Classical to Modern Times." (Lecture I).
At University College, Gower Street, W.C. 5.30 p.m. Prof. W. M. Dixon, "England, The Bible, and Shakespeare." (Lecture I).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. G. McN. Rushforth, "The Windows of a Medieval Church, and their Treatment as a Pictorial Scheme."

FRIDAY, NOVEMBER 15..Chemical Industry, Society of (Chemical Engineering Group), at the University, Nottingham. Mr. J. Arthur Reavell, "The Scientific Heating of Liquids and Gases."

Dyers and Colourists, Society of, at Manchester. Dr. F. A. Mason, "Peter Griess."

Electrical Development Association, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Mr. G. E. Sharp, "Selling Time Switches."

Fuel, Institute of, at University College, Nottingham, 7 p.m. Dr. J. W. Whitaker, "Coals and their Impurities."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Special General Meeting.

London Society, at the Royal Society of Arts, Adelphi, W.C. 5 p.m. Mr. Lawrence Tanner, "Royal and Medieval Tombs of Westminster Abbey."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Mr. Francis Hodgkinson, "Journal Bearing Practice."

North East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-on-Tyne. 6 p.m. Dr. B. C. Laws, "The Behaviour of a Cargo Vessel during a Winter North Atlantic Voyage."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture V—Contemporaries of Ostrovsky; Pisemsky and Tolstoy."
At King's College, Strand, W.C. 5.30 p.m. Prof. D. Saurat, "The French Novel. Lecture IV—Le roman de la race et du travail—Jean Richard Bloch."
At King's College for Household and Social Science, 61 Campden Hill Road, W. 5 p.m. Prof. V. H. Mottram, "Human Nutrition." (Lecture V).
At the London School of Economics, Houghton Street, W.C. 5 p.m. Dr. H. Dalton, "The Foreign Office at Work."
At University College, Gower Street, W.C. 5.30 p.m. Prof. W. M. Dixon, "England, The Bible, and Shakespeare." (Lecture II).
At University College, Gower Street, W.C. 5.30 p.m. Sir Richard Lodge, "English Parties and Foreign Policy in the Eighteenth Century." (Lecture III).

SATURDAY, NOVEMBER 16..L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. Harcourt, "The Marvel of India's Canals."

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ROYAL SOCIETY OF A

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

ONE-HUNDRED-AND-SEVENTY-SIXTH SESSION, 1929-30.

NOTICES

NEXT WEEK

MONDAY, NOVEMBER 18th, at 8 p.m. (Cantor Lecture.) E. G. RICHARDSON, B.A., Ph.D., D.Sc., Lecturer at University College, "Wind Instruments from Musical and Scientific Aspects." (Lecture I).

Demonstrations will be given on the various instruments.

WEDNESDAY, NOVEMBER 20th, at 8 p.m. (Ordinary Meeting) P. MORLEY HORDER, F.S.A., "Urban and Rural Amenities." ROGER FRY will preside.

FIRST ORDINARY MEETING

WEDNESDAY, NOVEMBER 6th, 1929. MR. LLEWELYN B. Atkinson, M.I.E.E., Chairman of the Council, delivered his Inaugural Address on "Fifty Years of Electrical Science and Industry."

The Address will be published in the *Journal* on November 22nd.

REPRINTS OF CANTOR AND SHAW LECTURES

The three Cantor Lectures on "The Treatment of Coal," by Dr. C. H. Lander, C.B.E., M.Inst.C.E., M.I.Mech.E., and the three Shaw lectures on "Thirty Years' Experience of Industrial Maladies," by Sir Thomas Morison Legge, C.B.E., M.D., have been reprinted in pamphlet form (price 2*s*. 6*d*. each), and can be obtained from the Secretary, Royal Society of Arts, John Street, Adelphi, W.C.2.

A complete list of Cantor, Howard and other lectures, which are available in pamphlet form, can be had on application.

HISTORY OF THE ROYAL SOCIETY OF ARTS

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15*s*. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

PROCEEDINGS OF THE SOCIETY

INDIAN SECTION

FRIDAY, NOVEMBER 8TH, 1929

DR. T. DRUMMOND SHIELS, M.C., M.P., Parliamentary Under-Secretary of State for India, in the Chair.

The following paper was read:

THE INDIAN CINEMATOGRAPH INDUSTRY

By A. M. GREEN, I.C.S.,
Acting Trade Commissioner for India

In the paper which I have the honour to read before you this evening I hope to exhibit to you a happy but rare event, no less than the birth of an industry in India without the benefit of non-Indian money or brains, and without the encouragement and almost without the knowledge of any of the Indian Governments or Government departments. It follows that I shall not be much concerned—and I hope this will not disappoint my hearers—with the theory or practice of censorship as applied to films in India. In fact, if I mention censorship, the mention will only be incidental, and will deal mainly with the special Indian aspects of censorship which tend to hamper the industry of film production. My primary purpose, then, is to give you a brief account of the origin and present condition of Indian film production, and to venture on some brief speculations as to its possible developments.

Before I go further it is but right that I should indicate what qualifications I have for addressing you on a subject which would seem to require both technical and commercial knowledge. I confess at once that I can lay no claim to the former, and only to the latter in the capacity of a civil servant, whose avocations for the past fourteen years have brought him into constant touch with the commercial community in India, and for the last eight months in England. On the other hand, I have since 1922 been an *ex officio* member of the Bombay Board of Film Censors, a board which is the busiest of all the Indian Boards, and which is situate in the area where the indigenous producing industry is most active. I was also one of the two official members of a small committee of six which was appointed by the Government of India two years ago, to examine and report *inter alia* " on the organisation for the exhibition of cinema films and the film-producing industry in India." This committee, which was known as the Indian Cinematograph Committee, travelled between nine and ten thousand miles over the length and breadth of India, including Burma,

examined some 350 witnesses in the capital towns of practically every province, paid flying visits to a number of smaller places, attended numerous public performances and private views, and inspected a dozen producing studios. Our activities led to a report which was published in the summer of 1928, and had a happier fate than most blue-books, for not a few copies were actually bought, and perhaps read, by the public in India and elsewhere. Further, the Government of India is, I understand, at present considering the views of the provincial Governments on our recommendations. Whatever be the upshot, the members of the committee at least obtained some insight into the Indian industry, its technique or lack of technique, its finances, and its commercial and cultural possibilities.

At the very outset of our enquiry we were faced by a difficulty that, in the sequel, appeared to us remarkable, and this was that from no source, official or unofficial, could we obtain really reliable statistics or even an adequate conspectus of the position regarding the distribution, the exhibition, and still less, the production, of films in India. The prevailing opinion in both official and non-official circles was that the production of Indian films was negligible, and that the sway of American films was unchallenged. But we soon discovered that Indian films were being produced in astonishing numbers, that despite their great technical inferiority they were infinitely more popular with Indian audiences than imported films, and that exhibitors could, and did, pay a higher rent for Indian films than for any foreign films, except some of those featuring well-known stars such as Charlie Chaplin, Harold Lloyd, or Douglas Fairbanks. After we had examined and collated the figures supplied by the Boards of Censors, we discovered that in the year ending 31st March, 1927, no fewer than 155 indigenous feature films had been produced, 108 in India proper and 47 in Burma. The number of feature films produced in the United Kingdom was but 48 in the calendar year 1927, and 26 in the year before. This comparison of the English and Indian figures will, I think, be as surprising to you as it was to us.

When we tried to discover the actual origins of the producing industry, we could find nothing very definite. Actually, the first Indian film seems to have been one produced by a Mr. Phalké and screened in Bombay in 1913. This gentleman produced several successful films, and his business eventually became the Hindustan Film Co. of Nasik, which is still one of the leading Indian producing concerns. No accurate information could be gathered about the development of the industry between 1913 and 1921, when at last statutory censorship boards were set up and began to keep classified records. In the year 1921-22, 63 indigenous feature films were examined by the boards in India and 10 in Burma, or 73 in all. This does not, of course, mean that all the 73 films had been produced in one year, for when the boards were instituted all existing films had to obtain from them a certificate before they could be again publicly exhibited. In the next year 103 films were examined, and

undoubtedly this number also included a proportion of old films, as in the following year only 85 indigenous films came before the censors. In 1924-25 the number was 96, and in the following year came a surprising jump to 145. Thus, in four years the number of films produced had certainly more than doubled.

What had doubtless been happening since Mr. Phalké made his initial success was this. It had been discovered that to produce a film of a sort, crude, but nevertheless attractive to an average Indian audience, required little technical skill and relatively little finance. Hindu mythology in particular supplied popular scenarios ready to hand, with no possible trouble about copyright, and the Indian sun made elaborate studios and artificial lighting unnecessary luxuries. Indian photographers already abounded, and as no high standard was required, the development of film negatives and the printing of positives presented no great difficulties. Cinema cameras and raw film became increasingly easy to obtain; of actors of a sort, and of scene painters and carpenters there was no dearth. A vacant plot of land with an outhouse or two, and with mirrors or boards covered with silver paper to reflect the light, constituted an adequate studio. And so one after another locally trained or semi-trained camera-men started studios of their own. Some, of course, failed, but not a few survived, and when our committee took stock, no fewer than 21 concerns were found to be producing films in India proper and 17 in Burma.

Most of the regular Indian producers are at work in the Bombay Presidency. If one company in the state of Kolhapur and another in Baroda be included, 15 of the 21 are in that province, and 9 of them are actually in the town and island of Bombay. Less than half the total produce a steady output of films; the remainder produce spasmodically as they can raise the necessary working capital. Nevertheless, one Bombay concern produces as many as 15 films in a year, despite the fact that "shooting" is impossible for three or even four months out of the twelve, when the monsoon rains beat down into and flood their open-air studios. Calcutta is the only other part of India where there is any appreciable production, and of the four concerns there, only one, Madan Theatres, Ltd., has hitherto produced regularly. In Madras successful Indian films have been produced, but for various reasons the producing companies did not survive. In Delhi the well-known film, "The Light of Asia," was produced under the auspices of the Great Eastern Film Corporation, but, as will be seen later, this was not a purely Indian film, and does not strictly come within my purview. In Rangoon, however, there has been a remarkable output of Burmese films in recent years. There are in Rangoon no fewer than 17 producing agencies, although only about four are firmly established concerns with a steady output.

I have already given figures to show how rapidly Indian production has grown and how large a number of films are now available, but to gauge the hold

which Indian films have won on the affections of Indian audiences we must know what proportion of the available screen-time they command. Actual figures are not available, but a close approximation can be obtained by comparing the footage of Indian films examined by the Boards of Censors with the total footage so examined. The figures are, I think, very remarkable. In 1921-22 the Indian footage represented 9.03 per cent. of the total, and in 1927-28 no less than 21.2 per cent. The actual footage rose from less than half a million to nearly 1½ million, or by over 200 per cent. Such an expansion is all the more striking seeing that the period was one of trade depression, when the raising of capital for any form of speculative or even industrial enterprise was difficult in the extreme. Again, the percentages I have quoted indicate less than the true position. Indian films often have longer runs and are screened more times a day than imported films, and it is to my mind certain that indigenous films occupy a distinctly higher proportion of the total available screen-time than 21 per cent. The British Films Act of 1927 aimed at ensuring that after eight years 20 per cent. of the screen-time in British houses should be devoted to British films. The Indian industry had done better than this by its own unaided efforts before the British statute had become law.

I have already hinted that no very high standard of technique has hitherto been demanded or attained. The real truth is that the general standard is remarkably low in every respect. Most progress has been made in the actual photography, though it is of course a long way below western standards, and this is the more praiseworthy because of the lack in India of methods of precision, the constantly varying actinic value of natural light, and the difficulties that high temperatures cause in film laboratory work. Only two or three producers have hitherto used artificial light, and probably only one, the Maharashtra Film Co. of Kolhapur, with success. Marvellous and all-pervading as is the Indian sun, expert witnesses told us that for good film shooting natural light requires at times to be modified and corrected by artificial means. Cameras and raw stock are, of course, all imported, and developing and printing devices are either imported or improvised. The imported apparatus is not usually of the latest pattern. Again, the camera-men and technical staff generally are largely self-taught; only a very few have been out of India, and of these not all have had any training or experience worth the name. The artistic and dramatic eye is naturally missing, and any new photographic effect is almost invariably an imitation of effects witnessed by the operator in imported films.

The same criticisms apply to most of the directors and scenario writers. It has hardly been recognised that the composition of a good scenario demands a special technique, even when a good film story is ready to hand. Accordingly almost all indigenous films are long-winded and, to the occidental eye, lacking in dramatic appeal; and the action is seriously impeded by the clumsy length of the captions, which are sometimes thrown on the screen in as many as four

languages. The films themselves, again, are usually much longer than a western audience would tolerate, lengths of 10,000 feet, which require 2½ hours screen-time, being not uncommon for a feature film. But this is not necessarily a handicap in the case of Indian audiences, who are habituated to dramatic and other entertainments lasting long hours. Consequently, few Indian producers have yet felt the need for that careful revision, compression and editing, which give such a finish and impression of speed to the best western films. The fault can also be traced back to the fact that Indian producers first gave most of their attention to film versions of well-known tales of Hindu mythology and religion. Here they rightly reckoned on their audiences' pre-existing knowledge and love of the subject, and had no great incentive to strive for dramatic effect or even coherence. Such films command large and enthusiastic audiences, and obviously will continue to do so for many years. As an example of this, I may mention that quite the worst film which we saw, a film on the life of Sankaracharya, in which the direction, acting, continuity and photography were all of the crudest, held entranced a large Calcutta audience, mostly of educated Bengalis, who normally are the most literary and æsthetic of all the Indian peoples. Their intense love for the subject blinded them to the manifest imperfections of its presentation. A similar audience in this country, however popular the subject, would have had its money back or wrecked the theatre. The cost of this Bengali production, we were told, was about £375.

Popular though the religious or mythological film was and is, producers, as time went on, felt that the more sophisticated urban audiences needed other fare. Consequently they tried their hands on secular dramas, taking their subjects from Indian history, real or imaginary, and from modern Indian life. Here their lack of imagination and artistic propriety is evident. They copy the most blatant faults of western films, and have recourse wholesale to direct plagiarism, both for incidents and even for whole plots. The results to the cultured eye, European or Indian, are frequently ludicrous, especially in the case of social dramas, which, more often than not, are merely American plots incongruously garbed in Indian dress and settings. Such films may draw audiences from that part of the uncultured urban population in Bombay and other big cities which has acquired the cinema habit, but all Indian audiences undoubtedly prefer—and I hope will continue to prefer—films of which the inspiration is really Indian.

I have already indicated that the technical staff of the Indian studios is essentially untrained. Such is the scarcity of trained men, or even semi-trained men, that often one man combines several functions, and is at once producer, director and even camera-man. But a still greater problem is the supply of actors, or rather actresses. There are many excellent dramatic performers in India, but the profession, as indeed was the case in England not so very many years ago, is, to say the least, not very highly accounted. In reputable Indian dramatic companies the women's parts are still, as in

Elizabethan days in England, played by men or boys. This expedient has even been tried for film work, but met with well-merited failure. Thus actresses have been found essential, and in the past have mainly been drawn from the dancing-girl class. This reacts on the supply of actors, who in the circumstances can seldom be obtained from the more select or cultured classes. It also reacts more or less on all connected with the industry, to which a certain stigma undoubtedly attaches. Consequently, it is seldom that men of culture or education are attracted to the industry, either as actors, producers, or even financiers. Happily, however, there are honourable exceptions, of which I will make some mention later, and signs are not wanting of a general improvement.

Some of the larger studios maintain permanent companies of actors and actresses and pay them regular monthly salaries. In these companies a "super" may draw £2 or more a month, and a star—for there are stars—as much as £60. The difficulty of obtaining respectable Indian actresses has opened an avenue of employment to Anglo-Indian girls. Some of them play Indian roles with real skill, and are among the most popular stars. One of them, who goes by the stage name of Sulochina or Water Lily, is a Jewess whose family presumably came from Iraq. In a short space of time she rose from being a telephone girl on about £9 a month to a film star on a salary six times as high. My Indian colleagues on the Committee at first thought that no Anglo-Indian girl could adequately mime an Indian woman's gait and postures. They, however, hailed the heroine of a film viewed in Calcutta as the best and most beautiful Indian film actress whom they had hitherto seen, and on being told that she was no Indian but an Anglo-Indian, handsomely admitted their error.

Time does not permit me to describe all the other difficulties which Indian conditions impose on Indian producers, but a few must be briefly mentioned. First and foremost is the difficulty of a limited market. In the whole of the vast Indian Empire, including the Indian States, there were only about 360 permanent cinema houses two years ago, and I doubt whether the number has since become much greater. Practically speaking, a cinema theatre does not pay in India proper in towns of less than 50,000 inhabitants, unless special circumstances exist, such as the presence of British troops, large industrial works, or a considerable student population. Such towns number less than one hundred. In Burma, where the standard of living is higher, theatres can be successfully run in smaller towns. Now the amount of money that can be put into the making of a film depends on the amount of money that it can win when exhibited. The smaller the number of houses that can show it, the smaller must be the returns and the more economical the production. The big American producers can afford to spend millions of dollars on a single film because they have a world-wide market from which to recoup their overhead expenses. The Indian producer must be sparing in his outlay because he only has a small home market. And his home market is not only small in itself;

it is not even homogeneous. Most of the better-class houses cater for Europeans or cultured Indians who cannot stomach the average Indian film, except occasionally as a curiosity, because of its technical shortcomings. Nor are all Indian films suitable for all Indian audiences. Thus, provincial differences in Indian culture are such that a film based on Bengali life may be utterly unacceptable to a Bombay audience. The multiplicity of languages is another difficulty which is only partly solved by repeating captions in two or more languages. Illiteracy is still another difficulty, for a caption in a man's own language is useless if he cannot read it. But the biggest difficulty of all is the religious difficulty. Naturally a Mohammedan will not wish to see a film based on and glorifying the Hindu religion, and will normally stay away when such a film is screened. But think of the many fine film stories that might be drawn from Indian history, from the heroic exploits of the Rajputs, and from the glamorous splendours of the Great Moguls. The Indian producer has in some cases attempted to deal with such subjects, but has to walk very delicately. Partly because of his lack of skill, and partly because of the undue sensitiveness of the religiose, the censors have not infrequently had to make rigorous excisions or even to prohibit public exhibition altogether. Even when there is no dispute about the accuracy of the representation of a historical incident, objection may have to be taken on the ground that it may excite communal enmity and lead to a breach of the peace. Even a film prepared for exhibition at a baby week almost failed to pass the censors, on the ground that its subject matter might offend deep-seated susceptibilities. How seriously such considerations must crib, cabin and confine the Indian producer is only too evident. Taking into account these and the difficulties previously mentioned, the advance of the industry hitherto has been remarkable indeed.

The cost of producing the ordinary indigenous film of about eight to ten thousand feet may be as low as £375, and seldom exceeds £2,000. The average cost is certainly not higher than £1,500, and is probably nearer £1,000. In view of the demand for these films and the relative cheapness of their production, it is not surprising that the profit to be made out of them is considerable. The Bombay producers admitted that, taking the rough with the smooth, they made an average of 10 per cent. on their money, but though we assured them that we would say no word to the income tax authorities, they declined to show us any figures. Finally we formed the distinct impression that their profits were very much higher than they indicated. One producer told us informally, when we were inspecting his studio and our reporters were not present, that one of his films which had cost Rs. 30,000 to produce had brought back to him within a year no less than Rs. 100,000, or a clear profit of 233 per cent.

I have already stated that indigenous films command a better hire and yield a better return to the exhibitor than the ordinary run of imported films, and this is capable of demonstration by official figures. There is in Bombay an

entertainment tax, which of course imposes on exhibitors the duty of making returns of revenue to a supervising authority. At our request this officer extracted from his registers figures relating to six leading cinema houses. These figures showed that in the first half of the year 1927 the three leading cinemas in Bombay which had exhibited only imported films realised between them Rs. 242,061 from their taxed seats, while the three leading cinemas which had only shown Indian films realised from their taxed seats Rs. 283,580. Thus the Indian films won by over £3,000 in six months. Actually this is an under-statement, because seats costing 4 annas and less are not taxed and are not included in the returns. The revenue from the 4 anna seats in the cinemas showing imported films is inconsiderable, but the 3 and 4 anna seats in the cinemas showing Indian films are normally crowded and yield a very considerable revenue.

The reason for the popularity of indigenous films is not far to seek. After all, we all appreciate what we understand best, and the familiar, for a time at least, is also the popular. Hence, the average Indian audience likes to see films which, whether they exhibit the past or the present, the religious or the secular, represent Indian, or at least oriental life, habits and scenes. In this connection it is significant that probably the most popular imported film ever screened in India was the pseudo-oriental film featuring Douglas Fairbanks as the Thief of Baghdad. But familiarity is not always popular; it also breeds contempt. Of this an enterprising tea planter gave us an interesting example. He organised free cinema shows for his labour force, but found that they took very little interest in imported films. He then tried to get for them Indian films, but found the rental exorbitant. Undaunted, he next bought a camera himself, shot the every-day scenes in his tea garden, and exhibited them to his labourers, who were delighted to recognise themselves and their companions amid the familiar sights of their daily round. But after a time they came to the planter and said "So far so good; now show us how the sahibs live." The town and city dweller is, of course, no less desirous of variety; and herein lies the real danger which is facing the Indian producer. If he wishes to retain his existing market, he must cease to imitate and must improve his product. Can he do this? I think he can if he will set about his task in the right way.

Hitherto most producing concerns have been managed by small men of as little business as of artistic training and instinct. Working capital has been lacking and has perforce been borrowed at high rates. In most cases production is not systematized, with the result that there is serious waste of time and money. In fact, the industry is inefficient, not only in technique but also in business methods. Three of the members of my Committee thought that money could be attracted to the industry, and its efficiency improved, by the enactment of legislation forcing all exhibitors to devote 50 per cent. of their screen-time to indigenous films within a maximum period of ten years, and recommended accordingly. They also recommended various forms of State aid. The remain-

ing half of the Committee, of whom I was one, felt most strongly that, in view of the share of available screen-time which indigenous films had already won, a quota was entirely unnecessary, and further that its imposition would only perpetuate inefficient production, and lead to loss of existing audiences, the financial embarrassment of exhibitors, and a decrease instead of the desired increase in the number of cinema houses. In a minute of dissent we argued that what the industry required was organisation and business-like management, and we suggested that the publication of our report would bring to the notice of business-men that the producing industry had great possibilities. We accordingly envisaged the formation of limited companies, with adequate capital, management and technical staff, for the production and distribution of pictures, and also for the erection, at a later stage, of cheap but adequate theatres. We expressed the belief that such organisations would be able to produce infinitely better films at no greater expense than the crude films produced hitherto, and that the improvement in quality would prevent indigenous films losing their popularity and would pave the way for a larger circulation and an increased market. Lastly, we pointed out the scope for co-operation between East and West, and the possibility of such co-operation leading to the production of some Indian films of sufficient merit to obtain a market in the more critical countries of the West.

Such co-operation has not been entirely lacking. "The Light of Asia," which I have already mentioned, was a film based on the life of Buddha, produced under the auspices of an Indian company, acted mainly by Indians and shot almost entirely in India. The actual making of the film, however, was in the hands of non-Indians, though the artistic direction was partly Indian. Unfortunately, for reasons into which I need not enter, the film was an artistic rather than a financial success, and the Indian company relapsed into inactivity. More recently, in 1927-28, an enterprising British company sent technical staff to India, and in collaboration with Mr. Himansu Rai, who had played a leading part in "The Light of Asia," and actors entirely recruited in India, shot a film based on a fanciful tale written by Mr. Niranjan Pal, who was also the author of "The Light of Asia" scenario, on the building of the Taj Mahal. This film, entitled "Shiraz," has already enjoyed a "pre-release" run at a leading London house, and may, I understand, be enjoying another run at this moment. I trust this picture will be successful financially, for an artistic success it certainly is. The same firm, again co-operating with Messrs. Himansu Rai and Niranjan Pal, and an all-Indian cast, has more recently produced another Indian film entitled "A Throw of Dice," which has already been trade shown and has, I think, prospects of winning great popularity on western as well as eastern screens.

Side by side with these films I would place a 100 per cent. Indian film which was produced two years ago by two cultured Parsi gentlemen, one of whom actually directed it. It is entitled "Sacrifice," and is based on a work of the

famous Bengali poet Rabindranath Tagore. After a first and successful run in Bombay, its makers took the only positive copy to Calcutta to negotiate further releases. Whether dissatisfied with the offers received, or inspired by a laudable ambition, they brought the film to England to see whether they could tap the more extensive and remunerative markets of Europe. When we presented our report the result of their courageous enterprise was unknown. Subsequently it was learnt that they had succeeded, and that the world rights outside India of their film, suitably edited and reprinted, had been bought by a powerful film corporation. The film was also registered under the British statute as a British film, having been entirely produced by British subjects and in British territory. I witnessed it in India before its final editing, and found the plot strong and gripping, the presentation artistic, and the photography much above ordinary Indian standards. Some of the actors were persons of education and culture, a leading part being taken by a university graduate who gave a really fine performance. Here then is a leading case to show that purely Indian films of a better type than the ordinary can already be produced, and if produced can even aspire to a place on non-Indian screens

The notable success achieved by the makers of " Sacrifice " and the publication of the Committee's report led to the formation of many schemes for the production of Indian films. Some were too ambitious, some were not ambitious enough, and few seem to have come as yet to fruition. The most promising venture that I have heard of is the flotation by the makers of " Sacrifice " of a public limited company known as the Orient Pictures Corporation, Ltd. They have, I understand, interested Europeans resident in India, as well as Indians in their company, and have ordered out up-to-date technical plant of good quality, including a powerful mobile lighting plant. I am also informed that a large studio of the latest design, containing a specially planned laboratory and offices, is to be erected. The corporation hopes to start shooting films this month or next, and to produce one film a month. It intends to draw its actors from the educated classes, and has already secured the services of Indian ladies as well as gentlemen. Before long I hope to see some of their productions on British screens. An all-Chinese film has recently been commercially shown in London. If Chinese, why not Indian ?

Another venture of which I have recently had word is that of the Indian proprietor of " Pathé India," a business which distributes films as well as all kinds of cinema machinery and raw stock. This gentleman is contemplating the conversion of his business into a limited company, which, in addition to existing activities, will itself produce silent, and perhaps talking, films, and establish a chain of theatres by acquiring old, or erecting new, houses. Madan Theatres Ltd., who already control a large circuit, were understood to be about to improve their studio and to increase their production of Indian films, but I gather that the advent of the " talkie " has given them pause, as indeed it did to producers in other countries.

It is to be hoped that some at least of these ventures will be successful and will be able to put on the Indian market a regular supply of improved films at moderate prices, and thus preserve and diffuse more widely the taste for indigenous films. And by their agency the crying need for more theatres, or in other words, a wider market, can best be satisfied. But the burden should hardly be borne on their shoulders alone. The Government of India and some at least of the Provincial Governments have begun to realise that the film may be a most potent engine for propaganda on behalf of public health, agricultural improvement and the like, and for mass education in general. A lead has been given by the Indian Government railways, whose Publicity Department not only tries to attract tourist traffic, but has actually co-operated with agricultural and other officials to produce, for free exhibition to the cultivator, films illustrating improved agricultural methods and rural betterment. The railways have taken the long view, rightly holding that anything which tends to increase agricultural production will eventually bring them increased traffic. Open-air shows are given along the railway lines, and delight audiences numbering thousands. A whole show does not consist of educational or propaganda films: commercial films of high entertainment value are inter-mixed, and thus the pill is gilded. But while giving great credit to the originators of such propaganda, my Committee could not help feeling that much of the time, thought and money expended on this valuable work was being wasted, owing to the absence of expert assistance. From this the producers of propaganda films were suffering even more than the producers of Indian entertainment films. We accordingly strongly recommended a co-ordination of effort by the establishment of a central bureau with expert advisers, to meet the expenses of which all departments of the Central and Provincial Governments should be invited to subscribe, and which should arrange to produce propaganda films for all India, either in its own or in commercial studios. While our report was in the press our Secretary received a memorandum indicating that an official bureau more or less on the lines we contemplated had been in existence for eleven years in Canada, and had apparently been eminently successful. If a bureau be established in India there is every reason to hope that it will not only greatly improve and expand film propaganda and mass education, using perhaps the sound as well as the silent film, but will also guide and assist, by example and precept, the indigenous commercial industry. Whether a bureau will be established or not I do not know, but it is encouraging to find that an expert film producer is likely soon to go out to India for employment under the Railway Board.

I have, I fear, left myself no time to talk of the future, but perhaps the potentialities of the film in India are already apparent. That the cinema is an influence for good in India all the members of the Committee, by the end of our enquiry, were convinced. At present it only touches the merest fringe of India's millions, but those whom it does touch it undoubtedly in some measure

educates. It draws the lowest classes from the grog-shop, and others from less desirable entertainments. It enlivens existences that are too often drab and monotonous, and may serve to alleviate the disturbance of India's "pathetic contentment" by inducing its devotees to adopt new and more enlightened ways of work and of life. I believe that the leaven is beginning to work, and that the despised film is capable of helping on the ferment by causing a mild and desirable intellectual awakening among the masses. He would be a bold man who would prophesy how either India or the cinematograph will stand a few years hence, but perhaps I may indulge in a fleeting vision in which I see an Indian village of the future, where, as the cattle come home of an evening, the headman switches on the wireless for the daily news bulletin and market intelligence, and where in the village hall or schoolroom a talking film in turn amuses and instructs "kiddies and grown-ups too." First the sewing machine, then the bicycle, the gramophone and the motor became familiar sights in rural India. Is then my vision so extravagant?

DISCUSSION.

LIEUT.-GENERAL SIR WILLIAM FURSE, K.C.B., D.S.O., Director of the Imperial Institute, said he left India in 1893 and had never been back there, so that he was not familiar with the present state of the country, nor had he any technical knowledge with regard to films. He had been greatly interested, however, by the very informative account given of the efforts of indigenous producers in India and the success they had met with, at any rate with Indian audiences. The suggestions made by the lecturer towards the close of his remarks gave much food for thought For the last three years the Imperial Institute had had some experience with cinematography, the Empire Marketing Board having given them the apparatus, and also maintaining it, for the purpose of giving the rising generation in this country an attractive insight into the life and conditions in our Empire overseas particularly so far as agricultural conditions and mineral resources were concerned He knew, therefore, how difficult it was to keep up a sufficient and adequately varied supply of really well-produced films for such a purpose.

The film provided a marvellous medium for the right kind of education, by which he meant one which educated an audience without their being aware of it The ideal producer would be a scholar who knew how to impart his scholarship in an attractive way, and if he was helped by a photographer who was a real artist, wonderful things could be done. He had been pleased, therefore, to hear the lecturer refer to the possibility of co-operation between such experts and the people of India.

The Empire Marketing Board were determined to go on with the work, to let the youth of the Empire learn in an attractive way something about life in the different parts of the British Dominions.

MR. H. BRUCE WOOLFE (Managing Director, British Instructional Films, Ltd.) said that as one who knew something of the trials and difficulties of film production he must congratulate the pioneers of the film industry in India on their achievements. The lecturer said that in India there were 360 theatres. In England there were 4,000. England, moreover, enjoyed the advantages of a single language and

no religious difficulties to speak of; yet the percentage of screen time occupied by indigenous productions in this country was nothing like so large as that occupied by indigenous productions in India. Those who had brought such a position about were certainly to be congratulated.

It must be a joy for the producers in India to feel that a large and enthusiastic population was waiting to acclaim their work; he wished that was the case in England. There was, however, one danger in that situation. The film was not national, but international; and if producers became content to make films which satisfied the lower elements of their home population, but which could not be shown on the screens of the world, they would not make much progress. A world market was essential for progress and real success, but he saw no reason why Indian films should not obtain it.

Of two of the films the lecturer mentioned he could speak from personal experience, because they were made by his own company. "Shiraz" had been shown in the leading theatres of all the principal European countries; it was being shown in Australia and South Africa as well as India, and was now bringing in revenue from the U.S.A. The revenue accruing to his company from that film from the continent of Europe was higher than they had obtained from any other film they had handled, and he thought the final figures would head their list of receipts from foreign sales. It was too early yet to say what would happen with the film "A throw of dice." When it was half-completed the "Talkie" boom commenced, but already the receipts from the continent of Europe was very little behind those of "Shiraz."

There was every prospect, therefore, that if Indian films, acted entirely by Indians and made entirely in India, were produced according to Western standards, they would meet with a welcome on the screens of the world; if Indian producers showed foresight and courage they should have no difficulty there.

He was pleased to hear the Indian railways were fostering the use of instructional films. Russia produced large numbers of cultural films; in Italy a film of that type must be shown at every performance; when an educational or cultural film was shown in Germany, a certain amount of entertainment tax was remitted; France was supporting an organisation for the collection and distribution of such films; Belgium, Czechoslovakia and several other European countries were doing a great deal to further the exchange and distribution of films which, as General Furse had said, educated people without their being aware of it. In England, however, very little was being done. Could it be that this country was right and all the other countries were wrong? It was a question which should be pondered over.

Mr. Rushbrooke Williams said that on listening to the paper he felt the same sort of melancholy, almost as it were post mortem, satisfaction as Huss would have felt could he have looked down from the heavens on the Reformation, for in 1920 he did his best to get the Government of India to face the question. Through the patriotic action of one of the largest film-producing houses in England, he had been successful in obtaining a preliminary survey by an expert, at the film-producing company's own cost. He was sorry to say the report of that expert was pigeon-holed; had action been taken on it, it might have simplified the valuable labours of the Indian Film Committee.

The cinema in India was among the most important of all educative influences. Like the lecturer, he had been struck by the immense enthusiasm displayed by the man in the street in India for films dealing with Indian history and legends. The displaying of such films in theatres other than those which specialised in imported films was even commoner up country than in the big Presidency towns.

It seemed to him the influence of the cinema in India might work along two converging lines. First of all, the very real interest taken even by the poorer classes in India in films which dealt, for example, with some incidents in the Mahabharatha was likely to give a new meaning and colour to the old traditional culture. With the combination of Eastern taste and Western skill, the man in the street would find the range of his interests enlarged, moreover, and in addition to the representation of his own culture he would demand some touch of the West Along those two lines progress was likely in the near future.

Though suffering from the lack of the latest apparatus and properly-equipped studios, the Indian producer had certain great advantages. He had the most wonderful range of public and historical buildings in the world round which to group his scenario, and had at hand a very cheap and picturesque crowd. In American films, for example, in the larger productions a considerable part of the cost was incurred in hiring crowds. Once the technical side of picture-making was improved in India, those advantages would make themselves felt.

The film " A throw of the dice " was filmed in Jeypore, by the courtesy of the Government there, and no doubt large numbers of Indian States, containing wonderful relics of Mughal and Hindu architecture, would be willing to help any company which desired to film an incident or story within their borders

SIR ATUL CHATTERJEE, K.C.I.E., High Commissioner for India, thought Mr. Rushbrooke Williams might be mistaken in imagining his representations to the Government of India were without effect ; it was probably as a result of them that the Indian Films Committee was appointed.

With the progress of time India, with its population of 320 millions, ought to provide a fairly large audience for purely Indian films, but he was most anxious that a correct and vivid presentation of Indian life should be available for the world at large, and he agreed with Mr. Bruce Woolfe in thinking that Indian producers should aim at a world market. There was a very large demand all over Europe and America for really correct descriptions of life in India ; India had suffered through incorrect presentations, and the Government of India were most anxious for improvement in that respect.

He had been struck by what the lecturer had said as to the length of Indian films. It was natural that, judged by Western standards, Indian films should seem long. Indian audiences were accustomed to very long dramatic performances, and liked to have full value for their money ; moreover, very little in the way of entertainment was available to enliven the dull and drab lives of the Indian industrial worker and peasant.

The lecturer had referred to the cultural possibilities of the film industry in India, and personally he thought there were very great possibilities in that direction A large number of educated Indian men and women were looking to the film industry for employment, and he believed many of those now engaged in it were highly educated people ; the lady who took the principal part in " Shiraz " was a distinguished university graduate. That indicated that the cultural possibilities of the film in India were very great. India had always been interested in dramatic performances, and would no doubt utilise the film as a cultural instrument, just as she used the drama in former days.

By the cinema and by broadcasting it should be possible to bring about a complete transformation of Indian village as well as town life. The dissemination of accurate and interesting news and useful information about agriculture and the various other pursuits of the people was extremely important. If the cinema

industry was developed by agricultural, educational and local authorities as well as by the Government of India a real transformation could be brought about, and broadcasting should be utilised in the same way. Anything which brought interest into the dull lives of the villages would be a most potent form of education and tend to raise the standard of living. At present there was a sort of vicious circle ; the standard of living was low and people could not go to the cinema, and because cinemas and so on were not well patronised people had difficulty in understanding the need for a rise in the standard of living and the necessity of earning more wages and becoming more efficient in the modern sense of the word.

MR. E. FOXEN COOPER (of the Colonial Films Committee) said the cinema industry appeared to have begun in India in the same way as it was started in this country ; it was taken up, he gathered, by people of the showman class rather than by educated men, and at first films were looked on merely as a form of entertainment, and were not of a very high order. In India as in England, however, it would probably develop into one of the most vital ways of educating every class of the population. He agreed with the lecturer that the cinema in India should prove an educational instrument of the highest order. The Colonial Films Committee, it might be of interest to remark, was at present carefully examining the best means of using the cinema to educate the natives of the various colonies.

MR. G. W. DAWSON (Indian Railways Publicity Department) said the lecturer had stated that the film industry in India had grown up without Government assistance, and that the Indian railways in producing propaganda films were handicapped by lack of technical knowledge, which had led to a certain wastage of effort. As one connected with the work of the department which produced those films he would like to give an account of what had been done.

In the last three years 79 films had been made, at an average cost of £140 each , the funds allotted were very small. The films were made to secure rural uplift, and to appeal to the ryot class. Just as the ordinary Indian producer had to make his films to suit his market, making them long, and making the action slow so that the people could follow it, so also the films he was describing had to be made to suit their audience. Except for tourist films, no attempt was made to make films for people outside India.

There were now eight cinema cars running on the Indian railways, and during the last official year 766 open-air shows were given, to an audience of 1,600,000 people ; sometimes the audience was as large as 30,000, all sitting in the open air. There were also special agricultural demonstration trains which toured the country. The fact that a man had a great deal of technical knowledge did not necessarily make him a good producer of films ; he must have a flair for choosing his subject and visualising his treatment of it. The Government of India did not take technical knowledge as the only criterion.

MR. S. G. TALLENTS, C.B., C.B.E. (Secretary, Empire Marketing Board) said that India was to be congratulated on the position she had achieved. In this country, so far as films were concerned, we were permanently bullied by America. Russia, having been cut off since the war from the rest of the world by a sort of *cordon sanitaire*, had developed a great film industry of her own, however much one might dislike some of the causes to which it was applied ; and he gathered India was now going to do the same sort of thing.

He hoped Indians would not listen too much to what was said about an international market. If good Indian films were to be produced, the first thing was for

Indians to make the best films they could from a purely Indian point of view. *If they were good enough, they would find a market elsewhere.*

He was a little surprised by Mr. Foxen Cooper's statement that films rose from the entertainment level to the instructional level; personally, he thought the two things were different; on the one side there was the art of the cinema, and on the other side its instructional aspect, though such a film as Mr. Bruce Woolfe's "Life of a Plant" was a masterpiece in both fields.

One of the great problems which had to be faced was the bridging of the great gulf which existed all over the world between the results of scientific research and their application on the farms and in the villages. He believed the cinema held unlimited possibilities for bringing the discoveries of the laboratories to the service of the men who should apply them in the fields, and the lecturer suggested that in India a real attempt might be made to make films of that kind. If that were done, India would give a lead to the whole Empire which was badly needed.

The story the lecturer told of the tea planter who tried to interest his men in the cinema reminded him of an incident which happened on a plantation in Africa, where the owner took a film of his workmen, who came with great interest to see it. It so happened, however, that one of the men who appeared on the film died a few days afterwards, and when the labourers saw the picture of the dead man on the screen they fled in a body!

The LECTURER, in reply, said he wished in the first place to thank the Chairman for sparing the time to be present and preside that afternoon; it showed the deep interest he took in Indian affairs. All those who had spoken agreed that the cinema in India had immense possibilities. Mr. Bruce Woolfe suggested that if the Indian producer would hitch his wagon to a star he had a great world market before him. Personally, he feared it would be a long time before that happened, and in any case there was a big market to be found in India. To get a world market for Indian films it might be necessary to make use of that terrible blight, the "universal appeal," which was usually an appeal to the worst rather than to the best; but if the films were really Indian, though they might appeal to a certain number of people, they could not appeal very frequently to the man in the street in England or America. It was only occasionally that one could hope to see an Indian film in England.

Mr. Dawson's remarks were interesting as showing that more had been done in India by Government than he himself had realised, but he thought his criticism still stood: the spirit was excellent, but the execution was not very good. So far as the films were intended for home consumption they were all right, but he had yet to see an Indian film that was good enough for propaganda in this country and still less in America. He hoped, therefore, that expert assistance would be forthcoming on the technical side and Indian production would improve.

THE CHAIRMAN, on behalf of all those present, thanked the lecturer for his interesting address, and congratulated him on the very hard work which, as a member of the Committee in India, he had done to produce their report.

Personally, he regarded the production of indigenous films of Indian life, suited for exhibition to Indian audiences, as very important. He agreed that a world appeal was also important, but thought that the picturesqueness of life in India would have a universal appeal if properly presented. The first concern, however must be to interest and entertain the people of India themselves. He would like

India to be affected by all the forces which were having a world effect, and undoubtedly the cinematograph was one of these. He said that not only in the hope that India would modify it and direct it to her own advantage, but also so that India might make in that direction, as in many others, a contribution for the lack of which the world was poorer at the present time.

A great factor in India was the cheapness of production. Though the wonderful light obtainable for the greater part of the year did not entirely remove the need for artificial illumination in some cases, it was a tremendous advantage, and there could be no doubt the situation in regard to light in this country had been one of the factors which had hindered the development of English films. Moreover, as had been pointed out, the picturesqueness of the crowds and their ready availability was another factor which cheapened production.

The advent of the "talkies" had practically paralysed the home industry, at least for a time. In India their effect would be twofold. There were so many vernaculars that a talkie in one language would not be of much use for people who spoke another, but on the other hand, a talkie in one of the commoner languages should make a big appeal to an illiterate audience who could not read the ordinary captions.

The difficulty of securing actors and actresses in India was interesting to notice. and was another instance of how the conditions of development in India were similar to what they had been in this country. Many people were fond of stressing the differences between East and West; personally, he was always more surprised at the great similarity between them. It was necessary to foster the spirit in India, as it had been necessary to foster it at home, that work which was for the welfare or recreation of the people was honourable work.

A lot had been said about dull villages, and the importance of the cinema there. There might be a danger that the film industry, if left to private enterprise, might for financial reasons not reach the villages. One reason for the depopulation of the countryside in Australia, and especially where an attempt was being made to form group settlements, was that the women in particular wanted to move to the nearest town, where there was a cinema. It would be a pity if anything happened in India to increase the drift to the towns. The railways, by their cinema cars, had shown one way of overcoming the difficulty, but there were many thousands of miles in India where no railway existed. The question might be considered, therefore, of having motor outfits which could tour the villages, either under private enterprise, if it was likely to be financially successful, or undertaken by Government. These motors could show instructional films, with some spicy ones added to give entertainment.

Personally, he was especially anxious that health films should be shown in that way. He believed it would pay the Government to show throughout India films exhibited in that or other ways which would teach simple lessons in hygiene and preventive measures against the great endemic and epidemic diseases which took such a toll of life there. In any development of the cinema that should not be forgotten.

He was interested to find that Charlie Chaplin was popular in India. When his friends became pessimistic about India he always said that he found such a fine sense of humour amongst Indians that he could not but be hopeful for their country. because where there was a sense of humour there was a sense of proportion and good judgment.

He was glad to see so many people present and taking an obvious interest in India, and he was sure they had all benefited by the lecture.

The proceedings then terminated.

OBITUARY

Sir Valentine Chirol.—Sir Valentine Chirol, who died on October 22nd, at the age of 77, at his London home in Carlyle Square, was born on May 23rd, 1852, the son of the Rev. Alexander Chirol, of Catsfield, Sussex. After receiving his education mainly in France and Germany, he became a clerk in the Foreign Office in 1872. Resigning his clerkship after four years in the Foreign Office, he spent the next sixteen years travelling in the Near and Middle East and elsewhere, frequently as correspondent of the old London *Standard*. In 1892, at the invitation of Moberly Bell and Sir Donald Mackenzie Wallace (then the Director of the Foreign Department of *The Times*), he became *The Times* correspondent in Berlin. When he went to Berlin, the relations between the British and German Governments were on a friendly footing and Chirol speedily established close personal contact with Baron Marschall von Bieberstein, then Foreign Secretary, and at a later date German Ambassador at Constantinople, and with Herr von Holstein, a leading figure in the German Foreign Office. As long as Caprivi was Chancellor, Chirol was in sympathy with the aims of German policy, which at that time was not unfriendly to this country, and, when in 1894, a proposal was made for a British lease of a strip of Congo territory between Lakes Tanganyika and Victoria to facilitate the construction of the projected Cape to Cairo railway, Chirol strongly supported the German view that such a lease would be contrary to the spirit of the Zanzibar Agreement. When, however, in the same year the Emperor replaced Caprivi by Hohenlöhe, the spirit of German policy underwent a change and the strong line taken by Chirol, in *The Times*, in regard to the famous " Kruger " telegram led to the doors of the German Foreign Office being closed against him and to a virulent campaign of abuse in the German Press. About a year after this episode, Chirol went to *The Times* office in London as deputy to Sir Donald Wallace, whom he succeeded as Director of the Foreign Department in 1899, remaining in that post until his retirement in 1912. India and the East was always one of his strongest interests. He made many journeys to India from 1883 onwards, and sympathised with many Indian aspirations. He was frequently consulted by Lord Morley in regard to the Morley-Minto programme of reforms, and his letters to *The Times*, afterwards published in the form of a book entitled " Indian Unrest," embodied his appreciation of the Indian situation and some frank criticism of many leading personalities, both English and Indian. Chirol was selected in 1920 to deliver the first of the annual lectures instituted in memory of Sir George Birdwood, his subject being " The Enduring Power of Hinduism." He also took part from time to time in the discussions of papers read at meetings of the Indian Section.

Joseph Leeming, F.R.I.B.A.—Mr. Joseph Leeming, who had been a Life Fellow of the Society since 1902, died on October 8th last, at the age of eighty, at Old Colwyn, North Wales, where he had been living since his retirement from professional work some twenty-five years ago. Born at Halifax, Yorkshire, he was the son of Mr. Alfred Leeming, of that town, and after being educated privately, was articled to Mr. Luke Horsfall. He commenced practice on his own account at Halifax in 1872, and in partnership with his brother was the architect of a large number of important public buildings in Yorkshire and Lancashire.

NOTES ON BOOKS

LIFE AND WORK OF SIR NORMAN LOCKYER. By T. Mary Lockyer and Winifred L. Lockyer, with the assistance of Prof. H. Dingle. London: Macmillan & Co., Ltd. 18*s*. net.

For various reasons the position occupied by Lockyer amongst the greater Victorian scientists is not one which lends itself very readily to assessment; but it would be difficult to imagine a more satisfactory method of presenting his work in its true light than that which forms the basis of this biography. So many of the controversies which he initiated are still living issues that something more than a mere history of his own investigations is needed; and it is, therefore, of peculiar value that in the second half of this volume a number of eminent authorities should have contributed critical appreciations of Lockyer's work in relation to the most recent views.

The desirability of such a treatment seems to arise from the unusual degree in which Lockyer was accustomed to think in advance of his facts. The caution with which his brilliant speculations were often received by the scientific world was due, not so much to a necessity for mental readjustment, as to a real scarcity of positive evidence by the light of which the new views might be judged. It remained to be seen whether the evidence, when it should accumulate, would be favourable or the reverse. In some cases, of course, it was favourable; but in others the original suggestion was shown to need great modification, or even abandonment; while others again, and those amongst the most important, are still unsettled problems.

Of the immense practical value of speculations of this type there can be no doubt; though they may be stigmatised as far-fetched, and may cause irritation in certain quarters, they act as unrivalled stimulants to experimental work. Lockyer himself puts the point in a nutshell when, in the course of a discussion with Father Secchi, he writes: "Sans une hypothèse qui dirigeait mon travail, j'aurais bien certainement beaucoup moins interrogé le Soleil que je ne l'ai fait"; and he quotes with telling effect Faye's epigram: "Une bonne théorie est aussi nécessaire qu'on bon télescope."

The detailed appraisement of Lockyer's work, to which reference has already been made, is preceded by a biography of more usual type, occupying just over half the book. Even here, however, the treatment remains somewhat impersonal: the career, rather than the man, is displayed. That career, it is perhaps needless to remark, was extraordinarily rich and many-sided, in the Victorian manner. It was also pursued, at all events in the earlier years, under conditions of unusual disadvantage; for Lockyer's official position, from 1857 until 1875, was that of a clerk in the War Office, his duties in this capacity consisting largely in acting as permanent editor of the Army Regulations. It is true that from 1870 he was lent as secretary to the Duke of Devonshire's Royal Commission on Scientific Education, and never actually returned to the War Office; but the whole of his valuable early work on the constitution of the sun was carried on in such hours as could be spared from his official duties; and our admiration does not diminish when we learn that in 1869 he took a leading share in the foundation of *Nature*, becoming the first editor of that periodical, an office which he continued to hold for no less than fifty years.

From 1875 the situation began to improve, as in that year he was formally transferred from the War Office to the Science and Art Department; but his position remained somewhat ill-defined and irregular, and the tentative and temporary nature of his appointments must for many years have been a source of anxiety. It was not until 1886 that his employment was put on a regular basis by his appointment as Lecturer in Astronomy at the Normal School of Science, the title of the office being changed to that of Professor in the following year.

His main life-work—the application of spectroscopic methods to the problems of astronomy and cosmogony—is admirably set forth in these pages. His great store of energy, however, found outlet in numerous other directions. Leaving out of account such minor ventures as the compilation of an annotated handbook embodying the Rules of Golf, and the projected (though, unfortunately, not quite realised) publication of a book on "Science for Artists," we find an astonishing record of valuable work of a secondary character. Of this, perhaps the most important was the tireless pressure exerted in forcing on the attention of successive reluctant Governments their responsibilities towards Science in this country; and his achievements in this field alone would have sufficed to win for him the gratitude of his scientific successors.

THE TYPOGRAPHY OF NEWSPAPER ADVERTISEMENTS. By Francis Meynell. London Messrs. Ernest Benn, Ltd. 2 guineas.

A great many people ought to know by now that Mr. Francis Meynell is a man of taste; quite a large number are aware that he is one of our leading typographers.

The advance of typography is part of that general counter-offensive of the arts against philistinism which marks the post-war decade. Quantity has been tried and found wanting; quality stands a chance of coming into its own. Machines having become universally familiar, their products will more and more have to be mixed with art if they are to be attractive. Printing, for instance, has got to be *fine* printing, or it will no longer tell.

Mr. Meynell, though a writer, publisher, printer and typographer himself, writes about his subject with a beautiful and critical detachment. He sees the wood in spite of the trees. If one can become sufficiently insensitive to the amazing exaggerations and absurdities with which advertisement abounds, it is clear that the æsthetic activity which its presentation evokes may be found absorbing and delightful.

The rules of this special art are analysed by Mr. Meynell with perfect lucidity. It is a visual art, involving principles familiar to the student of painting, and indeed of any of the fine arts. As time goes on we may hopefully expect that greater restraint and a better sense of proportion will be shown by the humbler as well as by the rare and distinguished members of Mr. Meynell's calling.

The æsthetic appeal of a fine, illustrated advertisement is, however, bound to be impure: tainted with a non-æsthetic purpose, which is, to make people buy such-and-such an article. Again, Mr. Meynell's analysis of the psychological principles at issue is admirable.

The introductory essay is followed by ninety pages of type specimens, whose set piece, in the great legibility trial, is the famous: "Quousque tandem abutere, Catilina, patientia nostra?" After that we get tables of the measurements of types—all most useful—and finally a "gallery of contemporary advertisements."

This is a book which need not be recommended; I should not be surprised if it became a kind of best seller, and again, a limited fine-paper edition would probably be bought up with eagerness by people in every part of the world.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 18..Architects, Royal Institute of British, 9 Conduit Street, W. 8 p.m. Mr. Alan E. Munby, "The Design of Science Buildings."

Arts, Royal Academy of, Burlington House, W. 4 p.m. Prof. Dr. A. P. Laurie, "Methods of Wall Painting."

Brewing, Institute of, at Charing Cross Station Hotel, Strand, W.C. 7.45 p.m. Prof Dr. R. H Hopkins and Mr. J. A. Burns, "The Proteolytic Enzymes in Germinating Barley."

Electrical Engineers, Institution of, at the University, Liverpool. 7 p.m Dr. N. W. McLachlan, "The Theory and Practice of Modern Loud Speakers."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr Carveth Wells, "The Colour of Ruwenzori."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m Mr. A. G Brown, "Artificial Lighting of Factories and Public Buildings (Joint Meeting with Students' Sections of the Institution of Civil Engineers and Institution of Electrical Engineers)

Public Works, Roads and Transport Congress, at the Royal Agricultural Hall, Islington, N. 2 30 p.m Mr H. C Head, "Tar in Road Making and Treatment." Mr G Marlow Reed, "Local Authorities and the Safety First Movement"

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. C Barnard, "The Education of Girls in France under the Ancien Régime." (Lecture I)

At King's College, Strand, W.C 5 30 p.m. Rev G. R. Woodward, "Ecclesiastical Music Lecture II - Carols."

At King's College, Strand, W.C 5.30 p.m. Prof H. Zickendraht, "Scientific Radio Research in Switzerland." (Lecture I.)

At the London School of Economics, Houghton Street, W.C. 4.30 p.m. Mr. E. H Warmington, "The Debt of Medieval Explorers to Ancient Discoverers." (Lecture I)

At University College, Gower Street, W.C. 2 p.m Dr. O. L. Brady, "England in Shakespeare's Day Lecture VI Alchemy and the Alchemists"

At University College, Gower Street, W.C. 5 30 p.m. Miss E. J. Davis, "How London became the Capital of England." (Lecture I.)

TUESDAY, NOVEMBER 19..Anthropological Institute, 52 Upper Bedford Place, W.C 8.30 p.m Prof W J Sollas, "The Sagittal Section of the Human Skull."

Arts, Royal Academy of Burlington House, W. 4 p.m Prof. Dr. A P. Laurie, "The Theory of Colour and its Application to Painting"

Automobile Engineers, Institution of, at the Engineering Scientific Club, Wolverhampton 7.30 p.m Mr W. H. Goddard, "The Mercedes-Benz Diesel Engine"

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m. Prof. E. G. Coker, "Some Experimental Methods and Apparatus for Determining the Stresses in Bridges and Framed Structures"

Heating and Ventilating Engineers, Institution of, at Milton Hall, Deansgate, Manchester. 7 p.m. Mr O. Stott, "Fan Standardisation Committee's Report"

Historical Society, at Bruce Grove School, Tottenham, N. 6.30 p.m. Miss D. Dymond, "St. Anselm."

Public Works, Roads and Transport Congress, at the Royal Agricultural Hall, Islington, N. 11 a.m. Mr. B. Price Davies, "The Arrangement and Economics of a Town Plan."

3 p.m. Miss J. F. Abram, "The Inter-relation of Public Services and Town Planning."

Statistical Society, at the Royal Society of Arts, Adelphi, W.C. 5.15 p.m. Prof. J. H. Jones, "The Present Position of the British Coal Trade."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Informal Meeting. Opener—Mr. W. Oldham.

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1861. Lecture VI—John the Dread."

King's College, at 40 Torrington Square, W.C. 5.30 p.m. Dr. J. Krzyzanowski, "The Polish Novel in the 19th Century. Lecture V—Eliza Orzeszkowa and her Fight for the Oppressed."

At University College, Gower Street, W.C. 5.30 p.m. Col. D. C. Cameron, "Some Administrative Difficulties of Mechanisation."

At University College, Gower Street, W.C. 6.30 p.m. Mr E. T. Elbourne, "Engineering Management." (Lecture II.)

Zoological Society, Regents Park, N.W. 5.30 p.m. Scientific Business Meeting

WEDNESDAY, NOVEMBER 20..Arts, Royal Academy of, Burlington House, W 4 p.m. Prof Dr A. P. Laurie, "Early Methods of Oil Painting."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Students' Meeting. Address by Mr. G. C Bunn, Chairman of the Committee of London Students

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield. 7.30 p.m. Mr A. Tustin, "Organised Scientific Research and Engineering Progress."

At the Cleveland Technical Institute, Middlesbrough. 7 p.m.

Geological Society, Burlington House, W. 5.30 p.m.

Literature, Royal Society of, 2 Bloomsbury Square, W.C 5.15 p.m.

Mechanical Engineers, Institution of, at the Grand Hotel, Sheffield 7 30 p.m. Mr H J. Davies, "The Effect of Shape and Surface Conditions on the Resistance of Materials to Repeater Stresses."

Meteorological Society, 49 Cromwell Road, S.W. 5 p.m. (1) Mr M. G. Bennett, "The Physical Conditions controlling visibility through the Atmosphere." (2) Dr L. F. Richardson, "The Reflectivity of Woodland Fields and Suburbs between London and St. Albans" (3) Flora C. Marwick, "The Electric Charge on Rain."

Microscopical Society, 20 Hanover Square, W 8 p.m. (1) Dr. P. de Beauchamp, "*Dicranophorus hudsoni* (Glascott)" (2) Dr. J. A. Hewitt, "Sarcocystis in Human Heart Muscle." (3) Mr. T. E Wallis, "The Projectograph an Optical Instument for the Projection of Images of Microscopical Objects."

Public Health, Royal Institute of, 37 Russell Square, W.C 4 p.m. Dr. Malcolm Donaldson, "The Early Diagnosis and Treatment of Malignant Disease."

Public Works, Roads and Transport Congress, at the Royal Agricultural Hall, Islington. 11 a.m. Mr. G. H Hargreaves, "A Simplified Method for the Design of Single Span Frame Bridges." Mr. C. S. Chettoe, "The Widening of Highway Bridges."

3 p.m Mr. T Peirson Frank, "Bituminous Road Surfacing" Dr. Percy Spielmann, "Road Emulsions."

United Service Institution, Whitehall, S.W. 3 p.m Colonel A. Brough, "Modern Military Bridging."

University of London, at King's College, Strand, W.C. 5.30 p.m H E. The Esthonian Minister, "Modern Esthonian Literature. Lecture I—Esthonian Folk-Lore"

At King's College, Strand, W.C. 5.30 p.m. Prof. H. Zickendraht, "Scientific Radio Research in Switzerland" (Lecture II.)

At King's College, Strand, W.C. 5.30 p.m. Prof. W. T. Gordon, "The Contribution of King's College to the Advancement of Learning during the Century 1829–1928. Lecture VII—Geology and Geography."

At the London School of Economics, Houghton Street, W.C 6 p.m. Lecture VII on "Office Machinery."

At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Lirica del Paradiso." (Lecture III)

At University College, Gower Street, W.C. 5.30 p.m. Mr. I. C Grondahl, "Some Norwegian Writers of the Present Day (Riksmaal)." (Lecture III.)

At the Royal Veterinary College, Great College Street, N.W. 5.30 p.m. Major G. W. Dunkin, "Recent Researches on Immunization against Distemper in the Dog." (Lecture III.)

THURSDAY, NOVEMBER 21..Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 7.45 p.m. Captain L. W. Johnson, "The Inspection of Metals and their Alloys." (Joint Meeting with Institution of Automobile Engineers.)

Chemical Society, Burlington House, W. 8 p.m. (1) Mr. T. M. Lowry, "The Rotatory Dispersion of

[illegible] Validity of [illegible] F. [illegible] and [illegible] "The Influence of the Sulphur Atom on the Reactivity of Adjacent Atoms or Groups, Part III—[illegible] and [illegible] Chloro-sulphides." (2) Messrs. G. M. Bennett and W. B Waddington, "Studies in the Penthian Series Part II —[illegible]." (3) Messrs. G. M. Bennett and W. B Waddington, "Studies in the Penthian Series Part III—Stereoisomeric Derivatives of some Penthianols." (4) Messrs. F. G. Angell, A. D. K. Drew and W. Wardlaw, "A New Interpretation of the Isomerism [illegible] Co-ordination Compounds of Platinum."

Electrical Association for Women, 46 Kensington Court W. 7 p.m. Mr. H Bourne, "How Electric Heaters Cookers and Cleaners are wired, and why they get out of order."

Electrical Engineers, Institution of, Savoy Place, W C 5.30 p.m. Discussion on "Low Temperature Carbonisation of Fuel with special reference to its Combination with the Production of Electricity" Introductory papers by Messrs E. H. Smythe and E G Weeks (English practice) Mr. I McEwen (American practice), Prof. Dr. Ing P. Rosin (German practice)

At University College, Southampton 7 30 p m Dr. J. W T. Walsh, "Illuminating Engineering

Historical Society, at Wandsworth Technical Institute High Street, Wandsworth, S W 8 p m Mr H Wilson Harris, "Ten Years of the League of Nations

Linnean Society, Burlington House, W 5 p m

L.C.C., The Geffrye Museum, Kingsland Road E 7.30 p.m. Mr. E J. Warne "Mouldings their Proportion and Place in Design"

Mechanical Engineers, Institution of at the Queens Hotel, Birmingham 6 30 p m Mr J I [illegible] "Coal Measurement"

At the Hotel Metropole, Leeds 7 30 p m Mr H J Davies, "The Effect of Shape and Surface Conditions on the Resistance of Materials to Repeated Stresses

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m

Public Works, Roads and Transport Congress at the Royal Agricultural Hall, Islington N 11 a m Mr G L. Pepler, "Water Supply as a Factor in Town and Regional Planning" Mr F C Temple "Successive Separation in Sewage Disposal Systems Mr. H. D. Bell, "The Application of Bleaching Powder as an Auxiliary Treatment of Sewage"

3 p.m. Dr. W. Rushton, "The Purity of Drinking Water from the Biological Aspect" Dr J B Firth "The Preservation of Rivers and Streams from the Standpoint of Water Supply: Some Observations on River Pollution." Mr H. Criswell, "A Simple Treatment of Super-elevation, Transition Curves and Vertical Curves." Dr Percy Spielmann, "Road Research."

Rubber Technologists, Institute of, at the Manchester Cafe, [illegible] Buildings, Manchester 7 p m Mr. R. Dobrée, "Unburstable Balls."

University of London, at Bedford College for Women Regent's Park, N.W. 4.30 p.m. Prof [illegible] "[illegible]" (in French) Lecture VII

At King's College, Strand, W.C. 5 p m Dr W Robson, "Protein Metabolism." (Lecture II)

At King's College, Strand, W.C. 5.30 p m Mr T F [illegible] "[illegible] Music."

At King's College, Strand, W.C. 5.30 p m Mr I I [illegible] "[illegible] in the Eighteenth Century" (Lecture [illegible])

At King's College, Strand, W.C. 5.30 p.m. Dr J A [illegible] "[illegible] and the Discovery of the [illegible]"

At University College, Gower Street, W.C. 5.15 p m Prof. J. E. G. de Montmorency, "Monstrous Lawsuits and Trials in Various Countries from Classical to Modern Times" (Lecture II)

At University College, Gower Street, W.C 5 30 p m Prof. W. M. Dixon, "England, The Bible, and Shakespeare" (Lecture III.)

Victoria and Albert Museum, South Kensington, S W 5.30 p m Mr M. W. Brockwell, "The Van Eycks

FRIDAY, NOVEMBER 22. Chadwick Public Lecture, at the Royal Society of Arts, Adelphi, W C 8 15 p m Prof A E Boycott, "The Causes of Cancer

Engineering Inspection, Institution of at the Royal Society of Arts, Adelphi, W C 5 30 p m Mr T W Willis, "Saws their Manufacture and some Hints on their Use"

Junior Institution of Engineers, 39 Victoria Street S W 7 30 p m Mr H D Bush, "The Quick Running Oil Engine as applied and used in Railway Service"

Mechanical Engineers Institution of Storey's Gate S W 7 p m Mr J S Atkinson, "The Utilization of Low grade and Refuse Fuels including Town Refuse"

At the Merchant Venturers Technical College, Bristol 7 p m Mr W Sisson Chairman's Address "Standardisation"

Physical Society, at the Imperial College of Science and Technology South Kensington S W 5 p m (1) Mr D P Dalzell "Heaviside's Operational Method (2) Mr I T Hanson, "The Dynamical Theory Resonators (3) Mr F C Atkinson "Escapement Errors of Pendulum Clocks"

Public Works Roads and Transport Congress at the Royal Agricultural Hall, Islington, N 11 a m Mr B Price Davies, "Economical and other Considerations in connection with Roads and Bridges" Mr H P H Morgan, Practical Points to be considered in the Improvement and Widening of Main Roads 3 p m Mr W J Jones The Application of Electricity to Roads from the point of view of Street Lighting and Traffic Signalling Mr J Hunter Smith Reflections on the purposes and Scope of Agricultural Education" Captain G A Wright Land Drainage"

University of London, at King's College Strand, W C 5 30 p m Prince D S Mirsky, The Russian Drama Lecture VI—The Poetic Drama from Pushkin to Musorgsky"

At King's College, Strand, W C 5 30 p m Prof H Zickendraht, "Scientific Radio Research Switzerland" (Lecture III)

King's College at 40 Torrington Square, W C 5 p m Dr O Odlozilik, "Outlines of Czechoslovak History Lecture I—The Geography of Czechoslovakia The Early Settlers The Great Moravian Realm"

At the King's College for Household and Social Science, 61 Campden Hill Road, W 5 p.m Prof V H Mottram, "Human Nutrition" (Lecture VI

At University College, Gower Street, W.C 5 30 p m Prof W M Dixon, "England, The Bible, and Shakespeare" (Lecture IV)

SATURDAY, NOVEMBER 23 L.C.C., The Horniman Museum Forest Hill, S.E 3 30 p m Miss I D Thornley "Village Life in the Middle Ages."

Public Works, Roads and Transport Congress, at the Royal Agricultural Hall, Islington, N 11 a m Mr R Beveridge, "Costing as an Aid to Econom[illegible]

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

NOTICES

NEXT WEEK

MONDAY, NOVEMBER 25th, at 8 p.m. (Cantor Lecture.) E. G. RICHARDSON, B.A., Ph.D., D.Sc., Lecturer at University College, "Wind Instruments from Musical and Scientific Aspects." (Lecture II).

Demonstrations will be given on the various instruments.

WEDNESDAY, NOVEMBER 27th, at 8 p.m. (Ordinary Meeting). C. NORMAN KEMP, B.Sc., A.I.C., Secretary Royal Scottish Society of Arts, "The Examination of Coal and Coke by X-Rays." (Dr. Mann Lecture). DR. FRANK S. SINNATT, F.I.C., M.I.Min.E., will preside.

COUNCIL

A meeting of the Council was held on Monday, November 11th. Present :— Mr. Llewelyn B. Atkinson, M.I.E.E., in the Chair ; Sir Charles H. Armstrong ; Lord Bledisloe, P.C., K.B.E. ; Sir D. T. Chadwick, C.S.I., C.I.E. ; Sir Atul C. Chatterjee, K.C.I.E. ; Captain Sir Arthur Clarke, K.B.E. ; Mr. P. Morley Horder, F.S.A. ; Sir Herbert Jackson, K.B.E., F.R.S. ; Major Sir Humphrey Leggett, R.E., D.S.O. ; Sir Henry A. Miers, F.R.S. ; Col. The Master of Sempill ; Sir George Sutton, Bt. ; Mr. Alan A. Campbell Swinton, F.R.S. ; Mr. Carmichael Thomas, and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies (Secretary), and Mr. W. Perry (Assistant-Secretary).

The following candidates were duly elected Fellows of the Society :—

Brady, Edward Mark, Dublin
de Sousa, Dr. Jose Inacio, Bombay, India
Goddard, George, Thurmaston, Leics.
Greaves, Mrs. Florence E., Southend-on-Sea
Hogg, Major Oliver Frederick, R.A., London

Laemmle, Carl, New York City, U.S.A.
Pickwoad, W. A., La Paz, Bolivia
Sanderson, D. C. D., Rangoon, Burma
Sharratt, Oswald Sewell, Hull
Shethia, J. D., Calcutta, India
Teng-Kwei, Cambridge, Mass., U.S.A.
Tizard, Henry Thomas, C.B., M.A., F.R.S., London

Mr. H. T. Tizard, C.B., F.R.S., was elected a member of the Council in place of Sir Thomas H. Holland, who resigned his seat on the Council on his appointment as Principal and Vice-Chancellor of the University of Edinburgh.

A sub-committee of the Council was appointed to deal with financial questions relating to West Wycombe. The Sub-Committee consists of the Chairman of the Council (Mr. L. B. Atkinson), the Chairman of the Executive Committee of the Fund for the Preservation of Ancient Cottages (Mr. P. Morley Horder), and one of the Treasurers, with power to add to their number.

Sir George Sutton was appointed Chairman of the Examinations Committee in place of Sir Philip Magnus, resigned.

The arrangements for the present Session were further considered.

A quantity of financial and formal business was transacted.

SECOND ORDINARY MEETING

WEDNESDAY, NOVEMBER 13th, 1929. CHARLES VERNON BOYS, F.R.S., in the Chair. A paper on "New Developments in Hydraulic Pneumatic Engineering" was read by Mr. J. O. Boving. The paper and discussion will be published in the *Journal* dated November 29th.

CANTOR LECTURES

MONDAY, NOVEMBER 18th, 1929. MR. E. G. RICHARDSON, B.A., Ph.D., D.Sc., delivered the first of his course of three lectures entitled "Wind Instruments from Musical and Scientific Aspects." The lectures will be published in the *Journal* during the Christmas recess.

PRESERVATION OF ANCIENT COTTAGES

WEST WYCOMBE

Thanks to the generosity of Lady Binning, the Council hope very soon to have a Guest House in West Wycombe, where Fellows and all interested in the experiment

in educated control of an English village can obtain full information about the work and the ways in which they can help the cause.

Arlington Row, Bibury

The work of reparation here is now practically complete, but there remains a small derelict cottage opposite Arlington Row, which looks sadly conspicuous and forlorn. Mr. Wykeham-Musgrave, from whom Arlington Row was acquired, has offered to hand this cottage over to the Society if it will be responsible for its repair. The Vicar of Bibury, who has taken much interest in the work, thinks there would be no difficulty in finding a single tenant for the cottage if it were made habitable. Six hundred pounds is needed to restore the cottage and to pay off the balance of the repairs to Arlington Row. The work done has proved so satisfactory that it is hoped some generous lover of the Cotswolds will help the Society to clear off the debt.

Turkdean, Smarden, Kent

A question was asked in the House of Commons two years ago about this very typical Kentish yeoman's house, and the Society has been making strenuous efforts ever since then to see that its character should be preserved. They are glad to report that it is now in safe hands, and although its restoration may be a work of years, its owners are fully alive to the value of their property. The adjoining house is also in the same possession, so that the beautiful Kentish picture of houses grouped around the church is likely to remain unspoilt.

The Leasowes, Halesowen

The Secretary of the Shenstone Society, Mr. E. Edge, through the good offices of Mr. Harold Cox, appealed to the Royal Society of Arts to assist in the preservation of this once famous house and gardens. Shenstone ranked as a poet in a rather superficial age. Disraeli suggested that he should be remembered for better reasons. He says: "When we consider that Shenstone, in developing his fine pastoral ideas in the Leasowes, educated the nation into that taste for landscape gardening which has become the model of all Europe, this itself constitutes a claim on the gratitude of posterity. Thus the private pleasures of a man of genius may become at length those of a whole people."

A considerable correspondence was published in the *Birmingham Post*, and it is hoped that the property may be saved from becoming a building estate. We should like to appeal to any Fellows in the district to interest themselves in the matter, and suggest that the University of Birmingham might lend a hand in the good work.

When visiting Leasowes, the Society's representative took the opportunity of going over the town with the Vicar, who writes in his *Magazine* :—

Our Old Cottages

. . . . Mr. Horder is also the Chairman of a special body called "The Fund for the Preservation of Ancient Cottages," which has been formed by the Society of Arts to arouse interest in our old English Cottages and to endeavour to save them for posterity. He paid a very hurried visit, but he found time to look at those in our midst, and was horrified when I told him that it was seriously contemplated pulling down the pair by the Church Schools when an opportunity presented itself in order to improve the approach.

I am afraid I am guilty of having considered such an event, but I now make public repentance and see the error of my way! After all as Mr. Horder says, these old houses do give an air of distinction to the town and surely are welcome to the eye if only as a relief from the "red rash" that is so terribly visible here and on the way to Birmingham. I agree, and when you come to think, it is rather absurd that we spend thousands of pounds on buying a picture or an old book to keep it in this country at a price greatly increased because the United States desire so greatly these objects of beauty and antiquity, but when bought not one in ten thousand of us will ever see them, while we treat as of no value buildings of beauty and eloquent of the past which can never be replaced, and are visible free of charge to all and sundry.

Mr. Horder did not have time to look carefully at any other of our old buildings, but I have always had a soft place in my heart for the Georgian and Queen Ann brick houses that still exist in Cornbow and are well worth preserving.

Sudbury, Suffolk

Some interesting cottages in the main street have been saved through the energy of Mr. Basil Oliver, who represents the Society for the Protection of Ancient Buildings on the Royal Society of Arts Executive Committee. This is an admirable piece of work, especially when it is recalled that the American Ambassador recently visited the ancient town to receive the freedom of Sudbury.

PROCEEDINGS OF THE SOCIETY

OPENING MEETING OF THE 176th SESSION

Wednesday, November 6th, 1929

Mr. Llewelyn B. Atkinson, M.I.E.E., Assoc.M.Inst.C.E., Chairman of the Council, in the Chair.

The Chairman delivered the following address :—

FIFTY YEARS OF ELECTRICAL SCIENCE AND INDUSTRY.

It is the duty each year for the Chairman of the Council of the Royal Society of Arts to address the members at the first meeting of the session, and as

the Council and members have honoured me by electing me to this post, an honour which I deeply appreciate, I have given considerable thought to the question of the subject which should form the theme of my address. It is not unnatural that on becoming your Chairman I should have been led to look back at the picture in which the Royal Society of Arts presents itself to my mind, all my earlier recollections of it being as the forum at which were presented in papers at meetings and in Cantor Lectures the discoveries in and the principles of the practical applications of electrical science. I was, therefore, led to think that perhaps it would be useful if I were to survey in this address the fifty years since the birth of the modern electric era, and its growth during that period, since it so happens that I have been a personal witness of this growth. As the number of those, who like myself, have lived through this period of growth is sadly diminishing, a brief resumé with stress on the critical points of progress may have some use for those who will follow. The title I chose for the address was "Fifty Years of Electrical Science and Industry." Since this title was announced, my attention has been called to a book published by Professor, now Sir Ambrose, Fleming, entitled "Fifty Years of Electricity," and I have expressed to him my regret that I should have chosen a title so similar.

It is 2,500 years since Thales first observed the attraction of amber rubbed with silk upon small light particles of straw, etc., it is 320 years since Gilbert wrote his treatise "De Magnete,' when for the first time some scientific record of the magnetism of the lodestone was recorded, it is 180 years since the first frictional electrical machine was made by Otto Von Guerich, of Leyden, it is just over the century since Volta discovered the Voltaic battery, and not until 1820 was the property of an electric current in a wire to produce magnetic effects discovered, whilst less than 100 years ago Faraday discovered the production of electric currents by the movement of conductors relatively to magnets or to other conductors carrying electric currents.

History of Inventions.

From this latter discovery sprang the series of inventions of machines for converting mechanical energy, first of the human muscles and then of steam engines into the energy of electric currents. Beginning with machines, in which coils were moved to and from the poles of permanent magnets termed magneto electric machines, the power was augmented by the use of electro magnets, these at first being energised from batteries and then from separate magneto electric machines and culminating in the practically simultaneous invention by Varley, by Wheatstone and by Siemens of the dynamo electric machine, in which the small initial magnetism of the iron of the machine produces at first a very weak current magnetising the magnets, which as their magnetism grows, reinforce this result till the magnets are fully energised.

It is remarkable to note that S. A. Varley filed a provisional specification for such a machine on December 24th, 1866, Dr. Werner Siemens, on January 17th, 1867, communicated the invention to the Academy of Science in Berlin, and on February 14th, in London, independent papers by Siemens and by Wheatstone were read, communicating the same discovery, whilst the first dynamo constructed, which was the Wheatstone machine, was there exhibited. Thereby was born the modern electric age, 62 years ago, within my lifetime. But something more was needed than these produced, for all these machines gave a more or less intermittent current, and it was not till 1871 that M.

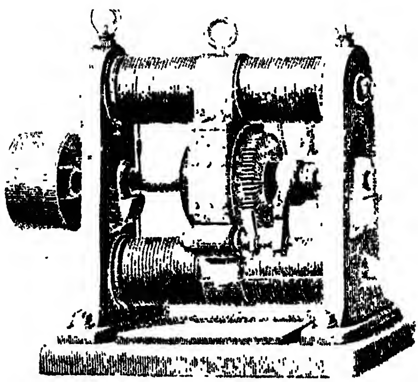

FIG. 1 Gramme Dynamo.

Gramme, of Paris, exhibited to the Academy of Sciences a dynamo electric machine with a continuously wound ring, which, sub-dividing the effect between a large number of successively acting coils, produced a substantially continuous current. The first use made of such dynamos and of the many others which followed was their use for running arc lamps, and as early as 1873 one was in use for running an arc lamp in the clock tower of the Houses of Parliament. At this time, it was recognised that to one lamp one dynamo was necessary, besides which the single lights were too powerful for any purpose except large halls or open-air lighting, and the problem of the sub-division of the electric light was the insistent one for the electrical engineer of the time. I well remember being in a cab in London with my father, it must have been about 1876 or 1877, when he told me that an inventor named Lontin had accomplished this. This Lontin did by using an alternating current machine having a number of fixed coils facing inwards on a ring, within which revolved electro-magnets excited by a separate machine, and the currents from the individual coils were taken to separate arc lamps, so now it became one *coil* to one lamp, each lamp being independent of the others. The earliest electric light in London streets was by such a system outside the old Gaiety Theatre in 1878.

The first real move forward commercially, that is, other than a matter of scientific interest, was found in the Jablakoff candle invented by a Russian engineer in 1876, and consisting of two parallel carbons separated by a vaporisable insulator, between which the arc gradually burned down. This was introduced to the world at the Paris International Exhibition of 1878, and such was the popular interest and appreciation of the new lighting by electricity, that the way was paved for the Paris Electrical Exhibition of 1881. But, before I deal with that, I must refer to some other matters.

In the early part of 1878, R. E. Crompton had brought over from France a Gramme dynamo and Serrin arc lamp to light the casting pits at the Stanton Ironworks, and in that year he commenced the manufacture of electrical machines and arc lamps at Chelmsford, and here in a few years he established an important and successful business, building a modified type of dynamo, designed by a Swiss engineer Burgin, which was mechanically a great improvement on the Gramme machine, and by 1880 lighting of goods stations and out-of-door areas by arc lamps was being actively entered upon by his firm.

In 1880-1881 the City of London was the scene of some wonderful experiments in electric lighting. A system of electric lighting devised by Charles Brush of Cleveland, America, and which had already been in use for a year or two in America, was introduced here. In contra-distinction to the solution of the problem of sub division of the electric light which I have already described, and which depended on the use of separate machines or coils, or separate circuits to each lamp, Brush placed all his lamps in series so that the same current traversed each. The regulation of the length of the arc of the lamp, which hitherto had been by a magnet operated by the current supplied to the lamp, so that as the length of the arc increased and so diminished the current the feeding mechanism was released, was in the Brush lamp effected by a magnet of high resistance shunting the lamp, so that as the length of the arc increased the shunted current increased and the magnet released the feed mechanism.

Crompton had modified the original Serrin lamp in the same manner, and at this time was running about six lamps in series, but Brush had succeeded in lighting as many as 40 lights in series, the possibility of doing this arising from the use of a different type of dynamo, which owing to its construction automatically maintained a constant current, whilst at the same time the system of commutation permitted voltages of 2,000 and over, without danger of flashing over. I think that the remarkable properties of this dynamo have not been fully recognized by modern electrical engineers.

Besides this system, part of the city was lighted by arc lamps on very tall masts, worked from Siemens' dynamos, one to each lamp, whilst in addition the Embankment was lighted by Jablakoff candles. This exhibition of electric light, vastly excited the public and determined my father and myself that I should be trained as an electrical engineer. But before all this happened another method of solving the problem of sub-division was being explored.

In the forties more than one inventor had had the idea of producing light by the heating effect of the electric current and more than one had suggested or experimentally tried to utilise carbon as the element to be heated, the carbon being in an air-free globe to avoid oxidation. Joseph Wilson Swan, in 1848, knowing of some of these experiments, had himself experimented, and by 1855 had produced suitable carbon spirals, but at that time batteries had to be used; the dynamo as the source of electric current was not available. But after the production of the Gramme machine, Swan resumed his work, and in December, 1878, he exhibited at a lecture at Newcastle-on-Tyne, a lamp with carbon filament in vacuo. Edison, working in America, had, in 1878, attacked the problem of sub-division, and, in December, 1878, had announced that he had solved the problem. His solution at that time was a lamp with a platinum spiral and a regulating device to prevent over-heating. In November, 1879, nearly a year after Swan's exhibition of carbon lamps, Edison applied for a British Patent for a carbon lamp and it was granted to him. It is on this fact that the American claim that Edison invented the practical incandescent lamp is based, but it is recognised by all competent to judge that he was preceded by Swan.

In 1880 Swan was producing these lamps in reasonable quantities, and in that year exhibited them at a lighting exhibition organised in Glasgow by the gas interests.

In the Electrical Exhibition held in Paris in 1881, and the Electrical Exhibition held in London in 1882, lamps of Edison and of Swan make were shown, and others by Lane Fox and Maxim, and the result on the minds of engineers, the public and the financial world was instantaneous. New dynamos, new lamps, both arc and incandescent, were produced on every hand, gas shares were almost thrown away, the wildest financial schemes were promoted, large sums of money passed from the public pockets to those of inventors and financiers. But, nevertheless, the real work of creating an electric lighting industry remained to be done, for at this stage nothing but lighting was envisaged. In 1882 came the first electric lighting bill, to which I shall refer later. It is difficult for electrical engineers to-day to envisage the difficulties which electrical engineers had to contend with. Up to 1881 measurements of electric current were generally made with a tangent galvanometer, an instrument only fitted for a laboratory, or a Siemens' dynamometer. Each of these were used because they had "a law," that is, if the constant was determined for one point, the value of the readings at other points was known. Voltages were measured by high resistance galvanometers, sometimes with scales and sometimes by null methods and mirror galvanometers. All these instruments had weak controls and so were very slow in reading. About 1881 Professors Ayrton and Perry introduced a series of direct reading dead beat ammeters and voltmeters; they were still obsessed by the idea of a law and the soft iron needles of these instruments were of carefully ascertained shape, so

that the value of the reading was directly proportional to the current. Other direct reading instruments followed, and the idea was at last realised, that a law was unimportant and that the instruments could be calibrated right through the scale and the dial marked to correspond. From this time onwards the advance of the new science was accelerated by the ease with which electrical measurements could be made. In 1883 Gaulard and Gibbs made a demonstration on the Metropolitan Railway, and also exhibited at the Aquarium, London, their transformer which enabled the pressure of an alternating electric current to be raised or lowered, with accompanying inverse change of the quantity of the current. The idea involved had occurred to several inventors, but ignorance of the principles underlying the design of such apparatus had prevented success. Gaulard and Gibbs laid down the principle that the two sets of coils between which the transformation was to take place, must lie one within the other, in other words, all the magnetic change in the iron core must equally affect each coil; as we should say to-day, there must be no magnetic leakage between the two sets of coils. They arranged the primary or high voltage circuits of all their transformers in series and supplied these with a constant current. The effect was a tendency for there to be a constant current in the secondary or low voltage circuit. Had the lamps been in series on the low voltage circuit, it would have been possible to turn these in and out singly without affecting the rest of the lamps, but as the lamps were arrayed in parallel the whole number had to be in use, otherwise the pressure rose and broke the lamps.

By 1885 it had been realised that if instead of a constant current supplied to the primary of a transformer, giving rise to an approximate constant current in the secondary, a constant voltage was applied to the primary, an approximately constant voltage would be developed by the secondary. On this principle a demonstration was made in London in 1885 and tests made by Professor (now Sir Ambrose) Fleming, demonstrated the complete independence of the transformers and of the lamps on the secondaries and that the transformation efficiency was as high as 92 per cent. From then onwards, the high pressure system of distribution took its place. It was strongly opposed by many engineers—on the ground that it was not possible to use accumulators, that the alternating current dynamo could not be run in parallel, and that it was not possible to distribute motive power, as alternating current motors did not exist.

The first objection stands good, but the growth of systems of alternating current distribution has justified the provision of spare running plant instead of accumulators, as the safeguard against failure, of supply. The motive power question was shortly solved as I shall mention directly, whilst in 1883 Dr. John Hopkinson demonstrated theoretically that alternating current generators would run in parallel and could be used to transmit power, a fact proved experimentally by Professor Grylls Adams in 1884, using two De Meritens

alternators at the South Foreland lighthouse. Mr. Henry Wilde had discovered this in 1868, but his paper on the subject " Synchronous rotation of armatures of number of electro magnetic induction machines " had been overlooked or forgotten.

Between the years 1886 and 1891 very intense study was given to the principles underlying the design of electrical generating plant, dynamos, alternators, motors, and transformers and to methods of calculating their design, and some remarkable papers were published, some of which I must mention. In 1886 Dr. John and Dr. Edward Hopkinson presented a paper to the Royal Society and almost simultaneously Dr. Kapp to the Institute of Electrical Engineers, in both of which the hitherto baffling problem of how to design the electro-magnet system of a dynamo was treated in a comparatively simple manner by introducing the conception of a magnetic circuit in which the magnetising coils gave a magneto motive force, the iron and the air space had each a magnetic resistance or reluctance, and the magnetic induction or number of lines of magnetic force was the quotient of the magneto motive force by the reluctance. It was shown that by the use of this idea with corrections for the fact that part of the magnetic circuit was outside of the iron of the armature (leakage) if the magnetic properties of a given sample of iron were known, the accurate pre-determination of the electro-magnetic system was possible. It is difficult for engineers to-day to realise what an astonishing revelation this was for designers.

Another very important addition to the methods of calculation as applied to alternating currents was introduced by Professor Blakesley in a series of papers he contributed to the " Electrician" about 1883, and which were published in book form in 1885. His method was a graphical one, in which the electro-motive force, current, or magnetic induction, were treated as pure harmonic or sine functions. By representing each of these, or several of them in different phases by lines whose lengths were proportional to their magnitude, and whose phases were represented by their relative angular position, and which were considered as revolving on one end in the plan of the paper as a pivot, it followed that the projection upon an axis passing through the centre or pivot represented at each moment the magnitude (positive or negative) of such function, and hence enabled calculations to be graphically performed, which would require rather cumbrous formulation in terms of trigonometry and algebra. Blakesley himself, using this notation gave the solution of a number of problems connected with circuits containing inductance and capacitance and of transmission of power by alternators. In the hands of engineers like Kapp, Silvanus Thompson and others, this method proved very fruitful and undoubtedly contributed greatly to the advance of alternating current theory and working.

With the solution of the problem of the magnetic circuit and with the graphical method of calculation for alternating current work an era of rapid evolution of design took place, and in this relation I will mention four papers

read before the Institute of Electrical Engineers, each of which in a way was a landmark in Electrical Engineering. The first was a paper by Kapp in 1888, on Electrical Transformers, in which the theory and method of calculation were developed in a manner that really completed the subject. In particular, a very simple conception for the calculation by the circle or vector diagram introduced by Blakesley was given, in which the fundamental variable was not the impressed primary E.M.F. but the magnetic flux.

Then in February, 1890, James Swinburne gave a paper on Armature Reactions, in which he developed the effects of the current in the armature of a dynamo generator, and showed how these effects which are detrimental might be partly or wholly overcome, and this paper made the suggestion of the use of reversing pole pieces in direct current generators or motors, a practice which, overlooked at the time, by 1900 had become universal.

In May, 1889, Mr. Mordey read a paper on Alternating Current Working, in which he described a series of remarkable experiments on the parallel working of Alternators and the transmission of power by their use, and in which he contended that he had disproved the theory of Hopkinson already referred to, though it was shown in the discussion that he had amply proved its correctness.

Finally, I will refer to a paper by W. B. Esson, given in April, 1891, on multipolar dynamos, giving a strong lead in the direction which shortly afterwards became the universal practice. The nett result of these papers was to put the engineering design of dynamo electric machinery on a firm footing; really very little of a fundamental nature has since been added.

Meantime, the drawback to the use of alternating currents, viz., that electric motors were not available for power transmission, except in the case of large units when the synchronised generator and motor, already referred to, could be used, had led to invention being concentrated upon this problem. Almost simultaneously Professor Ferraris in Italy, Dobrowolski in Budapest, and Nikola Tesla in America, found a solution in the supply of alternating currents, whose phases differed either by a quarter period or by one-third of a period. The simple explanation given, which is approximately correct, is that by winding coils on a ring of iron connected to these differing phases, so that the maximum magnetic effect passes in turn round the ring, there is produced a rotating magnetic field, and if a body of conductors are placed on an iron core so that this rotating magnetic field passes over it, electric currents are produced in such directions as to be acted upon by the magnetic field, so that the iron core with its conductors tends to move in the same direction and with nearly the same angular velocity as the rotating field. In 1891 there was an electrical exhibition at Frankfort-on-Maine, which I visited, and there was exhibited a three-phase motor of 100 h.p., to which power was being transmitted at 8,500 volts pressure from a fall on the River Neckar more than 100 miles away. From that moment the motor difficulty was recognised as being solved.

Though, strictly speaking, the development of the steam engine is not part of the subject upon which I am addressing you, yet, nevertheless, the progress of the steam engine has been so connected with and conditioned by the generation of electricity and *vice versa*, that I will say a few words thereon.

At the commencement of our story, steam engines in large sizes were slow running, 60 to 100 revs. per minute, having two or three cylinders, through which the steam was expanded before reaching the condenser. Generally, for land purposes, it was a horizontal engine, for marine purposes vertical, the valves were, as a rule, slide valves, moved by eccentrics on the main shaft.

About this period, however, engines with separately lifting valves, for the inlet and outlet of steam, were being introduced, the valves being operated by cams, which enabled a much better cycle of steam entrance and exhaust to be accomplished. With such engines and with the high speed at which dynamos had to be run, pulley and belt transmission was a necessity. Then began a period of experiment, directed on the one side to increase the speed of the engine, and on the other, to produce dynamos efficient at lower speeds. Among an enormous number of engines of varying type, an engine which had been invented by Peter Willans for river launch work, first used, I believe, directly coupled to a dynamo by Col. Crompton, achieved a marked success. The fundamental principle of the engine may be thus described. The cylinders, two or three, depending on whether the steam pressure justified a compound or triple expansion engine, were mounted in tandem on a single line of cylinders. The engine was single-acting and the steam from a cylinder on one line of piston exhausted into a cylinder of larger diameter on another line. In order to maintain the connecting rod pressure always in a downward direction upon the crank and so prevent hammering, each line of pistons had an air buffer cylinder in which air was compressed on the upward or idle stroke. This engine ran perfectly silently at speeds of 1,000 to 1,500 revs. per minute, it was very economical of steam and so far as engines up to 1,000 h.p. or a little over were concerned, it entirely solved the problem. The valves were of the piston type and worked in the centre of the line of pistons operated by an eccentric between two connecting rods. Above about 1,000 h.p., difficulties were experienced with the operation of this central valve, so there came a time when the development of electric generation went ahead of this remarkably successful machine. Meantime, as early as 1885, at the Inventions Exhibition in London, the Hon. Charles Parsons exhibited a dynamo driven direct by an engine, in which the steam passed through alternate fixed and moving blades after the manner of a water turbine, and enabling a speed of as much as 15,000 revs. per minute to be obtained. There were many ingenious devices to enable the rotating part to revolve about its own dynamic centre of mass and so to work without vibration. It is true the steam consumption was very high, up to about 20 lbs. per h.p. hour, largely due to leakage between the revolving part and the casing, but the small size of

the whole machine for a given output made its progress rapid. Through varying stages the steam turbine has marched to success, until to-day it has become well-nigh the universal engine for large power of any kind, and for electrical generation has practically no rival.

I have dealt at considerable length with the developments of dynamo electric machinery, because I was personally more especially interested in this side of the subject during the eighties, but I ought also to indicate developments in the distribution of electricity by cables. It is well known that in other countries, both America and the Continent, all the earlier developments were made by overhead wires, but in this country there has always been the strongest opposition to these.

At the commencement of the era of power and light distribution, Edison had invented a cable distribution system, consisting of two copper bars semi-circular in section, the flat sides facing and insulated from one another, insulated over all and fixed in lengths in iron pipes with junction boxes allowing service wires or mains to be tapped off. The system was workable, but costly to lay, and the number of joints a great drawback. Col. Crompton, in 1886, had devised a system whereby in a conduit under the road, bare copper conductors were supported on glass or porcelain insulators with straining fixtures at intervals. This system modified was used by other London Companies, but although the original system is still working in Kensington, it has in general been replaced by cables. The earliest insulated cables used in houses and also in streets were rubber insulated, a natural development from the gutta percha insulated cables, used for telegraphic underground work, and for deep sea cable insulation. But whilst rubber insulated cables work well for interior wiring, they deteriorated very rapidly when drawn into iron pipes underground alternately dry and moist from condensation from the air. In 1888, when Ferranti was laying out his great Deptford station, which was to supply London by current, brought from Deptford at the then unheard of pressure of 10,000 volts, he designed a system of conductors in which an inner hollow tube was insulated by being wound over with paper, dried and impregnated with tarry matters. This insulated inner tube was placed in another copper tube, which was drawn tight over it. These two, with a further bedding of paper, were placed into an iron tube, which was then drawn down tight onto it. By an ingenious system of mechanical joints the inner and outer tubes were forced mechanically into very intimate electric contact. Mains on the system have been in use for about 39 years, at 10,000 volts, giving practically no trouble whatever. But, obviously, the use of paper as an insulator in this way was only possible for a rigid conductor system laid in lengths of about 20 feet. In 1892, J. B. Atherton brought from America the process of making insulated cables by wrapping the cores with paper strips with overlapping joints and impregnating the paper with insulating oil and covering the whole in continous lengths with a lead pipe. The British Insulated Cable Co., Ltd.,

was formed in the same year to manufacture such cables, which from that time onwards became increasingly recognised as the best form for underground cables. The Callender Cable Co. introduced about the same time a system of cables insulated with a compound in which Trinidad bitumen was originally used and subsequently bitumen mixed with by-product oils, and vulcanised, which had a very wide use, though to-day, except for mining purposes, this type of cable is falling out of use. The paper-insulated cables referred to are made in a variety of types, for single feeder circuits, concentric, that is, one central conductor, with a layer of wire surrounding and insulated

FIG. 2.—3-Phase Paper Insulated High Tension Cable, with Pilot Wires.

from the central core, for three-wire systems, two cores of equal area and one smaller as the so-called neutral wire, three equal cores for three-phase work, and so on. The pressure at which such cables have been worked, have, until recent years, ranged up to 11,000 volt. Then experiments were carried out with their use up to 22,000 volts; latterly, that is in the course of the last few years, 33,000 volts have become not uncommon. Certain difficulties have occurred in some cases, with those latter, particularly after they have been laid some time, partly due to mechanical distortions occurring in laying cables of large diameter with considerable thicknesses of paper, and partly due to new joints problems. These have been in the main eliminated. For 33,000 volts and over it has become common practice to use three single-core cables, or its equivalent three insulated cores each covered with a thin metal covering or coating of metallised paper, these being finally enclosed in a lead sheath (the Hochstader cable). Experimental lengths are now in use and being laid of another type of cable where provision is made for restoring to the cable (which has a hollow core), on cooling, the impregnating oils which have been forced

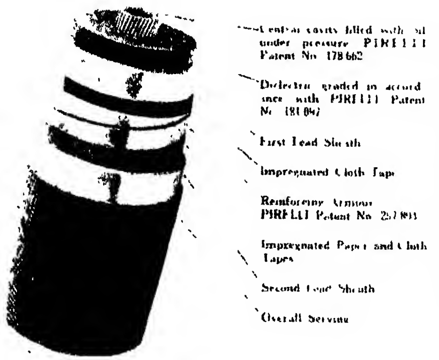

FIG. 3.—Single Hollow-Cored Cable for working under Oil Pressure.

out by the expansion of the oil, and thus the formation of air spaces is prevented (Emanueli cable). The use of oil under pressure passing up the hollow core was patented by Ferranti in 1888. Thus gradually the working pressure of cables has been raised from the 10,000-volt cable of Ferranti in 1888 to the 66,000 volt and 132,000-volt cable of to-day. Higher pressures still are under consideration and study in the laboratories. For internal wiring of buildings, except for special purposes, india-rubber or special compounds, largely composed of india-rubber, hold the field, being generally carried through tubing or protected by lead covering, or with thick rubber of special mechanical strength.

CENTRAL STATION SUPPLY OF ELECTRICITY.

I must now devote a few words to the initiation and realization of the Central Station for the Supply of Electricity. In 1882 Edison, who in 1880 had realized the requirements of Central Station supply, that is, large engines

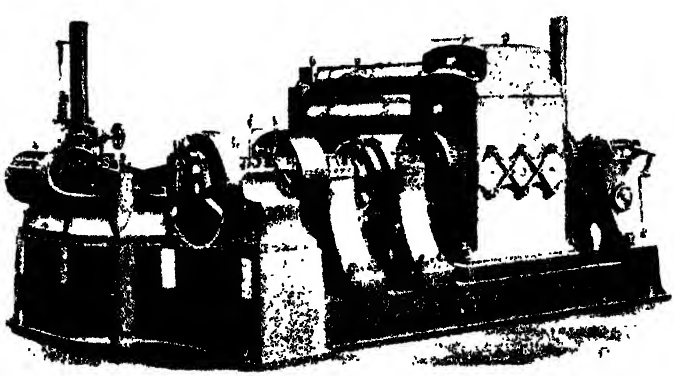

FIG. 4.—Combined Engine and Dynamo, Edison's First London Central Station.

and dynamos, very low resistance street mains and high resistance lamps in parallel, established on Holborn Viaduct a Central Station, with direct coupled 150 h.p. engine, supplying through mains laid in the street some 1,500 carbon lamps of 16 c.p. each, but the real Central Station lighting of London dates from 1886. In this year, Col. Crompton had completed an electric Central Station in Vienna, capable of working on full load up to 1,000 kilowatts, and at the same time had founded a Central Station in Kensington Court—a new residential area then just built—where with the help of an underground conduit running under many of the houses bare conductors on insulators could be run giving connections to the houses. The supply was by continuous current, generated by direct coupled Willans Crompton dynamos, giving 220 volts; the house supply on three-wire system with accumulators, giving 100 volts to the customers. Thus in London was the direct current supply inaugurated.

In the same year Sir Coutts Lindsay had started to supply certain customers in the West End from the electric lighting installation at the Grosvenor Gallery, the distribution being by Gaulard and Gibbs' transformers in series, as already described.

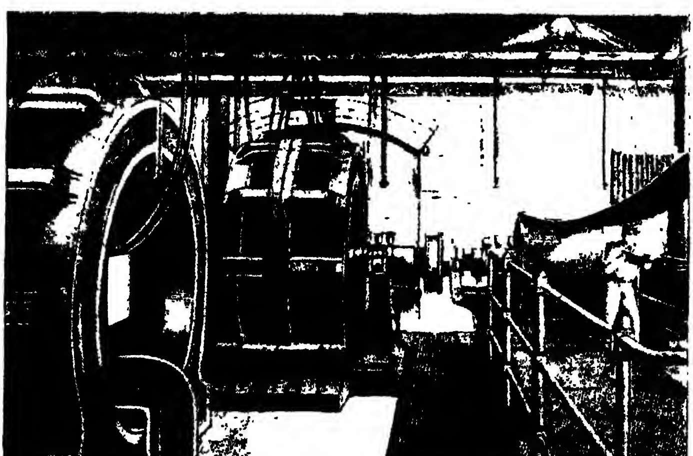

FIG. 5.—Ferranti Plant at Grosvenor Gallery, London.

In 1886 Mr. Ferranti (now Dr. Ferranti) was appointed engineer to the station and after some months of struggle with transformers in series, Ferranti advised that the customers should be supplied from transformers in parallel, as was done late in 1886, and from that moment success was assured, and in 1887 over 27,000 lights to 280 customers were being supplied.

In 1887 the plan of the great station at Deptford was completed, and in April, 1888, the machinery was put in hand, and by October, 1889, supply was given at high pressure, 10,000 volts to transformer stations in London—where the pressure was reduced—the prototype of every modern station.

From 1905 the carbon lamp which required about 4 watts for each candle power began to be replaced by other types, employing first the metal osmium, then tantalum, and finally, tungsten in the form of rods or wire for the filament. These metals enabled much higher temperature to be used with greater luminous power for a given consumption, the tungsten lamp giving 1 candle power for 1 watt, and in special forms with a slight internal pressure, due to an inert gas, such as nitrogen or argon, one 1 candle power for ½ watt. These new lamps gave a great impulse to electric lighting, which thus became as economical as any other form of illuminant.

Reference must also be made to some happenings which have greatly influenced Central Station working. The first of these to which I will refer was the remarkable paper by Crompton, read before the Institution of Civil Engineers in 1891, in which for the first time the economics of electric power generation were set out, and in which the great importance of what for the first time was called load factor, was set out. In that paper he set out figures of cost of electricity which he believed possible, which at the time were considered almost fantastic, but which have been beaten to-day.

The next item which left a lasting impress on the Industry was the Presidential Address given by Ferranti to the Institution of Electrical Engineers in 1911, in which he showed the advantage of the Universal distribution and use of electric power, a theme he has never ceased to expound.

The third matter, which has had an extraordinary influence for good, has been the publication month by month in the journal known originally as *Lightning*, and for many years now as the *Electrical Times*, of a table showing the production and distribution costs of electricity in all the London and provincial systems. The information given and the rivalry set up has been a strong impelling force for low costs. This feature was originated by Robert Hammond, writing under the nom de plume of "Chesterfield Junior."

The last item to which I will refer was the great increase of the use of electricity industrially after the war due to the great increase in the price of coal. I had long preached that the one thing necessary for increasing the use of electricity in Great Britain was a high price of coal, due to the fact that in isolated power plants coal is the heaviest item of cost, in electrical production and distribution it is secondary.

These four items have all co-operated to greatly stimulate the use of electricity in this country.

Telegraphy, Telephony, Wireless Communication.

I have not spoken of the application of electricity to telegraphy, telephony, and to wireless communication, nor can I draw to the same extent on my own personal experience, as in these branches of the industry I have only been a looker-on, but a few words as to the salient points may be noted.

The first telephone I ever heard was a pair of magneto instruments, made I think in 1876, by the father of one of my schoolfellows, before such were available generally, from a description which appeared in the *English Mechanic*, and I gave a lecture at school on the telephone in the year 1881, when they were first beginning to come into use. In 1879 an exchange was started in Glasgow among the medical men, and in 1879, later in the year, the first exchange was started in London with 12 subscribers. It is very remarkable that except in detail, the original carbon microphone transmitter and the permanent magnet and coil receiver have not been altered. But the exchange plant has altered, of course, out of all recognition, particularly with the coming of the automatic exchanges. The original exchange system in London and England belonged to the National Telephone Co., and there were a few cities with their own local exchange systems. The only one of the local systems left is, I believe, Hull, since the Government took over the whole of the National system in 1911, having already constructed and been the owners of the trunk or long distance lines.

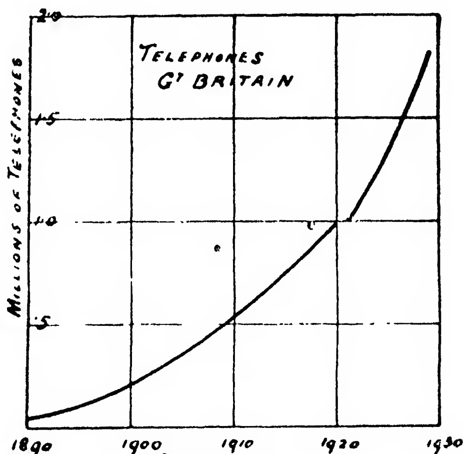

FIG. 6.—Diagram shewing growth of Telephones in Great Britain.

The greatest developments in telephony since the early eighties have been due to improvements in line construction and methods of working. Oliver Heaviside in the eighties had pointed out the requirements of a telephone line for perfect transmission of speech, but no use was made of his theoretical solutions, which involved artificially increasing the self induction of the line. Pupin in America, in 1899 developed the theory, and by putting self induction coils at mathematically determined intervals on the line, enabled very great distances to be covered. The use of these coils has not proved of great advantage on land lines in England, where the distances are shorter. But the bulk of telephone lines to-day are laid underground and the use of self induction coils on underground lines—referred to as loading coils—has led to great perfection in

speech transmission. In addition, the invention of the electron valve—which I refer to later—has enabled the circuit to be divided, and the weakened current to be reinforced at repeater stations, as they are called. So that in England the circuits which required conductors weighing 200 lbs. per mile are now equally efficient with conductors weighing 20-40 lbs. per mile. Telephone subscribers over the whole world now are, or in a few months will be, in touch telephonically with one another—a result very largely due to British skill and initiative.

The curve of growth of telephone subscribers shows that the number of telephone subscribers in this country doubles about every ten years. This country, however, stands badly in the matter of number of telephones per head of the population, and in some quarters it is considered that this will not be overcome until the Telephone Service becomes an independent unit, managed on purely commercial lines, without the implications involved in its finances being conditioned by treasury requirements or necessities, or its personnel being Civil Service officials.

The story of wireless telegraphy begins with the discoveries in theory by Maxwell in 1864, and in practice by Hertz in 1888, of the transmission of electro-magnetic impulses independently of wires. In 1887 Sir Oliver Lodge had achieved wave telegraphy by wire, and for short distance across space, but in 1896 Senator Marconi came to England and interested Mr. Preece, the Chief Engineer of the Post Office, in a method he had invented of extending the distance to which wireless signals could be transmitted. Substantially his improvements consisted in using much longer wave lengths then Hertz had done, using a vertical wire or aerial, as we call it, with an earth connection as transmitter, together with improved forms of receiver for electro-magnetic waves.

The first successful transmission over any considerable distance was made between Lavernock Point and the Flatholm Island on the Bristol Channel. Step by step Marconi developed his system. Improvements in detail and in the applied power led him to the point where transmission of signals across the Atlantic were possible.

A very important step was made in 1904, when Prof. (now Sir Ambrose Fleming), applied a long forgotten experiment of Edison (in which he showed that a current passed between the incandescent carbon filament of a lamp to a metal plate sealed into the globe but not in the reverse direction) to the production of a current rectifier, to enable the oscillating current from a wireless transmission to be converted into an unidirectional current, and so be used with a telephone as a signal detector. Shortly before the War, Dr. Lee de Forest invented a modification of the Fleming valve, by arranging between the hot filament and the positive plate a spiral or grid, as it is called, which could be independently electrified, and by suitably proportioning the electrification of this grid, the smallest change in its electric charge produces a much greater change in the electron stream from the hot filament. This modified Fleming valve acts

as an amplifier. It is by the use of such amplifiers that signals of extraordinarily small intensity can be magnified practically indefinitely. Sir Oliver Lodge, in 1907, had pointed out the desirability of tuning the receiving apparatus so as to be in electrical response or resonance with the transmitter, and by applying this principle not only is the receiver made more sensitive, but it enables a receiver to receive one wave length, or speed of oscillation, to the exclusion of others, and hence many transmitting stations can work at the same time without interference. The tuned receiver with the detector and amplifying valve have made wireless telephony and broadcasting possible.

ELECTRIC THEORY.

A review of the progress of Electrical theory in the period under review is in itself a story that would fill a course of lectures, and so can only in this address be taken in summary. The first actions to which attention has been drawn and measurements made were those known as electrostatic, attractions and repulsions between bodies which had been subjected to friction, and to explain these actions a theory had been formed that they were due to two fluids, which though ordinarily mixed could be separated. Then it was suggested that one fluid in excess or deficiency would account for the actions, in either case it being assumed that the action between the so-called electrified bodies took place at a distance with no intervening mechanism. When Ampère had discovered the attraction and repulsions between conductors carrying electric currents, he formulated " laws " which explained in a similar way the action of each elementary unit of the electric circuit acting on every other unit, at a distance. Faraday had never been happy with the idea of action at a distance; in his mind's eye he always saw something in the way of a connection across the intervening place, " lines of force " he called them, strings or rods as it were, in tension or compression, and this idea guided him in the experiments he made, which led, step by step, to his great discoveries. The mathematician of the 19th century up to about 1860 had worked upon the laws of electricity, entirely from the point of view of " forces " connected with units of electricity or of units of electric current acting across an intervening empty space. Such forces depending on inverse distance laws, had explained all observed phenomena from a mathematical point of view.

In 1864, James Clerk Maxwell presented a paper to the Royal Society on " A dynamical theory of the electro-magnetic field, in which he reduced all the observed phenomena to the results which would arise in a medium capable of transmitting stresses and strains and capable of rotational energy. The most strikingly novel part of this theory was the implication that during the period when a charge is being given to a condenser, that is, to an arrangement of two conductors separated by a dielectric, there is a movement of electricity in the dielectric, a displacement current as he called it. Following upon this, Maxwell, considering an electro-magnetic charge at a given point,

developed equations for the condition for another point at a distance and showed that the solution of the equations leads to the result, that the condition of things at a distant point depends on that of the initial point at a previous interval of time, the interval being that during which a light wave would have crossed the intervening space. I need not here proceed further with the demonstration he gave, that if light is a propagation of energy by the disturbance of a medium, light might itself be an electro-magnetic disturbance, and probably is so.

James Clerk Maxwell, in 1873, published his treatise on "Electricity and Magnetism," in which he developed these ideas, and taking Faraday's experimental researches as his foundation, he built up a theory of electrical actions dependent on the dynamical action of something filling all space on which matter could act, and he showed that if this something which he called the ether were a sort of continuous sub-matter having inertia and elasticity, all the actions which we call electrical, could be stated in terms of tensions and compressions of the *ether* or of its rotation. He further visualised and demonstrated that such actions are not instantaneous as was assumed in the action at a distant theory, but required time to develop, the effects proceeding from point to point, as happens in a wave motion, and that the velocity of propagation calculated from the electric and magnetic constants of space or of the ether was the same as the measured velocity of radiant transmission of light or heat, from which fact he propounded the theory that light and heat were electro-magnetic phenomena.

These views were in a short time accepted by British scientists and electricians, but were not received well on the Continent, where among the mathematical physicists the theory of action at a distance was accepted as philosophically more reasonable than transmission by a medium.

Maxwell himself never attempted experimentally the demonstration of the existence of electromagnetic waves, but Sir Oliver Lodge, about 1888, produced waves in wires by the discharge of a Leyden jar under conditions such that the discharge was oscillatory, and in 1888 H. R. Hertz announced his discovery that he had succeeded in so arranging the discharge of a condenser of small capacity, that ether waves which could be detected by a looped conductor with a microscopic spark gap were produced, and that they exhibited the phenomena of reflexion and refraction similar to light waves. Maxwell's theory so far was justified. It is on this discovery that wireless telegraphy and telephony is based. But whilst this showed the propagation of electro-magnetic actions, it brought no nearer the solution of the question, what is electricity?

In a long series of researches on electrical discharges in vacuo in the 70's and 80's, Sir William Crookes had observed that in a very highly exhausted tube, through which at high voltages a current was forced, there appeared a stream of light taking a straight line, but deflected by a

magnet. He considered that such a stream was composed of matter in a "fourth state," the others being gases, liquids, solids. About 1896, Sir J. J Thomson announced his discovery that the rays in a Crookes' tube are indeed caused by masses smaller than the smallest chemical atom and of a mass about 1/1800 that of a hydrogen atom, which he called corpuscles.

Not long afterwards Becquerel discovered that the element uranium gave off something which passed through opaque substances and blackened a photographic plate, and this observation led to the discovery of radium, the atoms of which are always disintegrating by stages, and which at certain stages of their disintegration give off masses having the same characteristics as the corpuscles of Thomson. The details of the process of disintegration of Radium were worked out in a wonderful series of researches by Sir Ernest Rutherford and F. R. Soddy, and these and other workers established definitely that these corpuscles are, in fact, the parts of what we call electricity and so were named electrons.

It was demonstrated by Rutherford that atoms of matter are composed of a nucleus in which most of the weight is concentrated and certainly in part made of electrons, and with which other electrons are associated.

As a mental image to enable some visualisation of the atom to be formed, we have had the Rutherford-Bohr atom so called after its proposers, in which a central nucleus or " proton " is surrounded by electrons circulating like planets round a sun. Such a visualisation clears many points, but always we are pushed back further. What is an electron, what is the nucleus or proton? That is where the physicists now halt. Tentative mathematical studies and some very remarkable experiments point to the possibility that an electron is itself a particular point in a system of waves Discussion of this is outside of my present scope, but the mention will suffice to summarise the change in thought that has taken place from the time of Faraday and over the period of 50 years. Whatever may be discovered in the future as to the nature of the electron and the atom, nothing will alter the discovered fact, that electricity is composed of discrete entities, or electrons and that matter is largely composed of electrons. Nothing will alter the fact that all radiation, whether light heat or wireless waves is a phenomenon electromagnetic in character.

Commercial and Financial Progress of Electricity.

Having touched upon the high lights of the picture of the development of electricity technically and scientifically, I now propose to deal with the commercial and financial side of the half century and growth. There are two separate sides to this, one is the growth of the constructional and manufacturing activity, the other the growth of public service in supply of electricity, in transport, and in communication as illustrated by the telephone. Each of these subjects would easily occupy an evening's lecture to itself, and hence, what I have to bring

before you will be necessarily only a brief review. In what I shall be showing you, I have had very kind and able assistance in compiling the statistics from Mr. Hugh Quigley, well known for his industrial studies and his statistical knowledge of the electricity industry. The figures and curves must be taken as representing very careful estimates drawn from a variety of sources public and private, and involving certain allowances and connections which are known to exist, but of which the exact amounts are not determinable. The data on which these figures are based do not go back further than the early years of this century so that we practically have no data covering the first 15 years of our period.

The electrical manufacturing industry in its early days was composed of a considerable number of small or moderate sized firms; this was natural, they were the concerns formed to exploit the special products of individual inventors, then as the industry grew older the longer established engineering concerns formed departments for electrical work. Above all, the manufacturing industry in Great Britain has seen the establishment here of manufacturing business based upon foreign manufacturing experience, and in some cases foreign capital, such as the Siemens Bros., originally co-operating with Siemens Halske, Berlin, the Brush Electrical Engineering Co., founded to manufacture Brush arc light plant, but capitalised in this country, The British Thomson Houston Co., founded to work the inventions of Professor Elihu Thomson, The Westinghouse Co., Manchester, founded to work the inventions and processes of the Westinghouse Co., Pittsburg, America, with partly British and partly American capital.

The Cable Making Industry relative to light and power cables was principally at first using india rubber as an insulator, and was naturally grafted on the important submarine cable-making industry (which had used rubber and gutta percha) existing on the banks of the Thames, where it had originated owing to the facilities for delivering cable in long lengths direct into the hold of the ships which were to lay them Here again new firms appeared such as the Callender Cable Co., who were formed to exploit a bitumen insulated cable, and the British Insulated founded to manufacture paper-insulated cables, with lead covering. Alongside of these have grown up entirely new firms, often fostered by Government Departments, who desire to augment the competitive sources of supply on which they can draw.

In considering the public supply and traction sections of the industry, as well as the telegraph and telephone, we have to realize that these do not represent natural commercial growths, but the growths of monopolies under state control. Let us review the action of the state in 1880-1, the period when public lighting by electricity was about to develop. Joseph Chamberlain, who had had a great experience in Birmingham of Municipal activities, was anxious as far as possible that the future of electric supply should be in the hands of the municipalities, as gas and water were coming to be at that time. Recognising, however, that there was a pioneering stage to be got over, he, then President of the Board of Trade, brought in and passed the first Electric Lighting Act of

1882, which provided for the granting of powers to set up central supply stations, with powers to break up streets, and to make and collect charges, but on the basis that at the end of 21 years the local authority could take over the concern, without any consideration for the goodwill, which 21 years of pioneering and establishing of a business would have created. The result was that for the most part the industry was strangled, there being no possibility of capital being invested on these terms, and whatever central stations were constructed at that time was by the use of privately acquired wayleaves and overhead connections. By 1888, it was recognised by everyone that the Act had strangled electrical development, and by an Act of that year, the period for purchase was extended to 42 years, with the result that considerable activity in electric lighting supply companies commenced, whilst Municipalities also by this time felt that sufficient experience was available to justify their entering the field as the electric supply authority.

Both these Acts of Parliament were marred by the underlying idea that the supply of electricity should be localized, that is, confined to a municipal or some other definite area, or a limited area in a great City like London. In 1919, a committee was appointed to report on certain Bills before Parliament, known as Power Co. Bills, whose aim was to create generating stations to supply in bulk and to large industrial users, over wide areas containing many local authorities, and as a result Acts were passed giving such powers, strictly limiting the entrance of the mains of such companies into the areas of municipalities, already exercising electric generating powers. Notwithstanding this limitation, such Companies have justified their existence and have the advantage of an unlimited tenure of their rights.

In 1922 and 1926, further legislation, relative to electric lighting control, took place. The effect of the first of these enactments, among other things, was to establish a body of Electricity Commissioners with a double function. First, to take over the executive functions, approval of schemes for provisional orders, approval of apparatus for metering, etc., making of bye-laws for the protection of the public, etc. which had previously been carried out by the Railway Department of the Board of Trade, and secondly to prepare schemes for the better supply of electricity to the public.

In the 1922 Bill it was intended to give the Commissioners certain powers of compulsion as to grouping of generating stations and distribution areas, but the opposition to this in Parliament was too strong, and the Commissioners were left with advisory powers only.

The 1926 Bill established a Central Electricity Board of independent business men, not Members of Parliament, and not financially interested in electrical production or distribution with new powers. The procedure was as follows: The Electricity Commissioners were to prepare schemes for improving the national supply of electricity; the Central Board, if they approved them, were to hear objections, and finally to put them in force. This provided the

element of compulsion lacking in the 1922 Act. The plan established by the Act made the Central Electricity Board the clearing house of all electricity supply. Certain generating stations, old or new, became selected stations, the current produced by them was produced for the Central Board and supplied by them to all other distributors. Other generating stations could continue if they sought fit, but they must charge as if their cost of generation were as low as the price at which the Board would supply it. Small stations which under these conditions would have to close up were allowed to apply the difference in price between their cost and the Board's price of current, to writing off the capital which was rendered idle by the provisions of the Act, which being done, the benefit of the decreased cost must accrue to the consumer. In order to connect up the selected stations, so that a minimum of spare plant would be necessary, the Central Board has raised capital separately for the purpose of erecting overhead connecting lines throughout the country, the so called "grid." It is anticipated that in about 10-15 years the small and inefficient stations, numbering nearly 500 will have been extinguished, and all distributing companies will have a supply on the same terms as those who in the past have best situated in this respect.

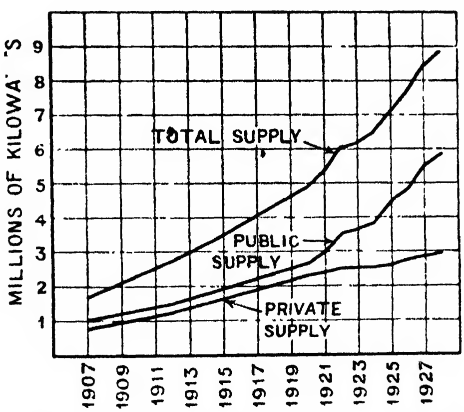

FIG. 7.—Capacity of Generating Plant installed in England

Fig. 7. shows the growth of the total capacity of public supply authorities, that is both Municipal and company, and the estimated capacity of plant owned privately in works and collieries, etc., and Fig 8. the estimated total output in millions of electrical units per annum.

Alongside of this growth of public supply for lighting and power which I have referred to was the growth of electric traction, carried out both by Municipalities and by Companies. Horse tramways, like electric lighting, had been the subject of powers of purchase exercisable by the local authorities at 21 years, and as the principal Act was passed in 1873, it followed that by 1894 all tramways were about to fall into the hands of the Municipalities, who

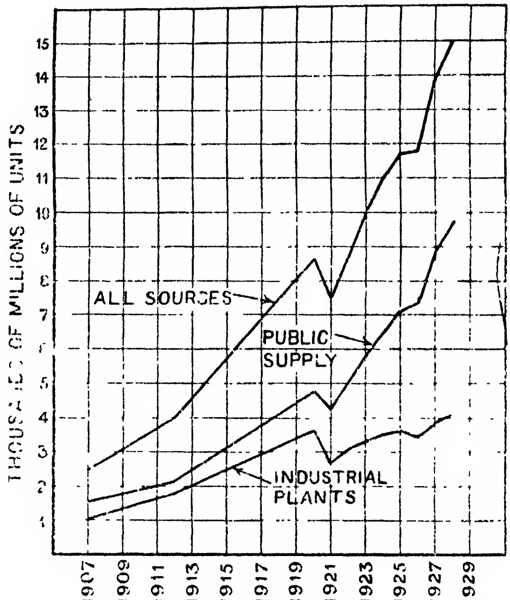

FIG 8.—Electricity Output in Great Britain.

exercised their powers of purchase, scrapped the lot, and built new tracks and equipped them electrically. The 21 year purchase clause proving in the case of traction, as in the case of electric lighting, outside municipal enterprise, to have closed all enterprise, an Act was passed in 1896 called the Light Railways Act, intended to encourage the creation of light electric railways, running alongside of roads, as in some Continental countries. This Act gave no powers of purchase to local authorities. It had very little effect in this direction, but as no one could tell whether any given line was a tramway or a light railway, a certain number of light railways were constructed under these provisions. It seems now as if the tramway, except where there is very heavy traffic to be carried on fairly open roads, has reached its zenith.

I will now turn to the question of the capital invested in electrical undertakings in Great Britain.

The upper curve on Fig. 9. on the next page, shows the total capital invested in all electrical undertakings, other than traction, by public supply undertakings, aggregating about £295,000,000, and the lower curve shows the capital estimated to be invested in electrical manufacturing concerns. This diagram covers the period from 1903 onwards, and it is interesting to note the acceleration in the rate of investment since the year 1919. i.e., during the post-war period.

In addition to the above, capital expenditure has therefore been incurred in connection with Electric Traction. Including the London Underground

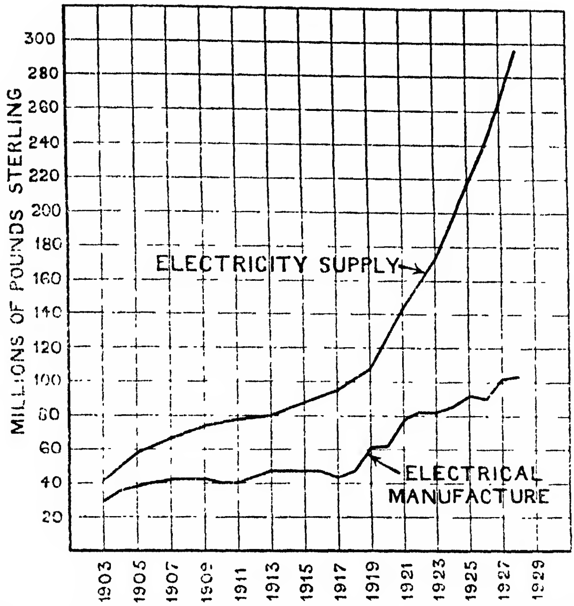

FIG. 9.—Capital Expenditure in Electricity *Supply* and Capital Invested in Electrical Manufacture.

Railways and the Metropolitan Railways, the capital outlay by companies on electric traction has been £183,000,000 and by municipalities £92,000,000 —a total of £275,000,000

The total capital invested in electric manufacturing, electric supply and electric traction is thus estimated at £671,000,000, and this does not include the amount invested by those who generate electricity for their own use, nor the amount invested in motors and appliances and in private installations for utilizing electric current.

Earlier on I referred to the position of the Royal Society of Arts as the forum before which most of the earlier discoveries and applications of electricity were first presented. I have prepared as an appendix to this address a list of such covering the eighties and early years of the nineties, a perusal of which will, I think, confirm what I have said.

I have now completed the survey, which I planned in this address. It suffers from being too general and yet too condensed. It has not touched on the great subject of the private and industrial uses of electricity. It covers a very remarkable period of our social and industrial expansion and I esteem myself fortunate to have been an eye witness of this growth. May we look at the probable future? Approximately over the last 25 years the consumption of electricity produced by supply authorities has doubled every 6 years. The rate, if anything, is increasing, and we know from the experience of other countries that the point of saturation is a good way off. The electrification of

main line railways has not yet commenced. We may without envisaging another period of 50 years, look forward say for 20 years to a period of great activity, both in the science and industrial applications of electricity.

APPENDIX.

Papers on Electricity read at the Society's Meetings between the years 1876-1891.

1876-7	The Telephone	Professor Graham Bell.
1878-9	On the Practical Applications of Electricity to Lighting Purposes	J. N. Shoolbred.
	Edison's Electro Chemical or Loud Speaking Telephone	Conrad Cooke.
1880-1	Recent Advances in Electric Lighting	W H. Preece
	The Electric Railway & Transmission of Power by Electricity	A. Siemens.
1881-2	Storage of Electricity	Silvanus P. Thompson.
	Electric Lighting at the Paris Exhibition	W. H Preece.
	Telephonic Communication	Lt.-Col C E. Webber
	The Fire Risks incidental to Electric Lighting	T Bolas
1882-3	Electrical Exhibitions	W H. Preece.
	The Measurement of Electricity ..	J N. Shoolbred.
	The Transmission of Power by the Portrush Electrical Railway ..	A. Siemens and E. Hopkinson.
	Electricity as a Motive Power ..	Prof. G. Forbes.
1883-4	Electric Launches	A. Reckenzaum.
	The Progress of Electric Lighting	W. H. Preece.
	Telpherage	Prof. Fleming Jenkin.
1884-5	Electric Lighting in America ..	W. H. Preece.
1885-6	Some Points in Electrical Distribution	Prof. G. Forbes.
	Domestic Electric Lighting ..	W. H. Preece.
1886-7	Glow Lamps; Their Use and Manufacture..	General C. E. Webber.
	Electric Locomotives	A. Reckenzaum.
1887-8	Electric Lighting from Central Stations	Col. R. E. E. Crompton.
1888-9	Electric Meters for Central Stations	Prof. G. Forbes.
	Arc Lamps and their Mechanism ..	Silvanus P. Thompson.
	Secondary Batteries	W. H. Preece.
	Prof. Elihu Thomson's Electro-Magnetic Induction Experiments	Prof. J. A. Fleming.
1890-1	Electric Lighting Progress in London	T. Bailey.

Cantor Lectures delivered between the years 1879-1892.

1879-80	Recent Advances in Telegraphy ..	W. H. Preece.
1880-81	Scientific Principles Involved in Electric Lighting	Prof. W. G. Adams.
1881-2	Dynamo Electric Machinery ..	Prof. Silvanus P. Thompson.
1882-3	Secondary Batteries and the Electrical Storage of Energy	Prof. Oliver Lodge.

1884-5	The Distribution of Electricity ..	Prof G Forbes.
1889-90	The Electro-magnet	Prof. Silvanus P. Thompson.
1890-1	Electric Transmission of Power ..	Gisbert Kapp.
1891-2	Developments of Electrical Distribution	Prof. G Forbes.

The Chairman then presented the Society's silver medals for Papers and Lectures delivered during the last session as follows :—

Papers read at the Ordinary Meetings : —

Sir Eustace Tennyson d'Eyncourt, K.C.B., D.Sc., LL.D., F.R.S., "Fuel for Ships."

G. G. Blake, M.I.E.E., F.Inst.P., "Applications of Electricity to Medical Practice."

Cecil Hooper, F.L.S., "Fruit Pollination in Relation to Commercial Fruit Growing."

James Morton, "History of the Development of Fast Dyeing and Dyes."

Professor A. E. Richardson, F.R.I.B.A., "Modern English Architecture."

G. H. Nash, C.B.E., M.I.E.E. (European Chief Engineer, International Standard Electric Corporation), "Some Modern Aspects of Electrical Communication."

Robert Burrell, Barrister-at-Law, "Reform of the British Patent System."

Papers read before the Indian Section :—

W. H. Moreland, C.S.I., C.I.E., "The Indian Peasant in History : an Introduction to the Linlithgow Report."

A. T. Cooper, M.Inst.C.E., M.Cons.E., "Recent Electrical Progress in India."

Papers read before the Dominions and Colonies Section : —

Colonel H. L. Crosthwait, C.I.E., "Air Survey and Empire Development."

Dr. H. J. Van der Byl, "The South African Iron and Steel Industry."

Trueman Wood Lecture :—

Sir Alfred J. Ewing, K.C.B., F.R.S., "The Vibrations of Railway Bridges : an Example of Co-operative Research."

Sir George Birdwood Memorial Lecture :—

Captain P. Johnston-Saint, M.A., F.R.S. (Edin.), "An Outline of the History of Medicine in India."

Sir George Sutton, Bt. (late Chairman of the Council), said there was one consolation for one who had relinquished the post of Chairman of the Council of the Royal Society of Arts ; apart from the fact that, if he was an indolent man, he could feel he had got rid of a great responsibility, he had the privilege of proposing a vote of thanks to the new Chairman for his Address.

Often the proposer of that vote of thanks would give some account of the career and achievements of the new Chairman, but the Address which Mr. Atkinson had given, a very instructive, entertaining and learned Address, gave a far better idea of Mr. Atkinson's career and qualifications than he himself could give by any recapitulation of the new Chairman's past achievements. Personally, he had been a contemporary of Mr. Atkinson's for very many years, and had witnessed his achievements and seen the great honours which had fallen to him, including, in recent years, the very great distinction of being appointed President of the Institution of Electrical Engineers. Great as that distinction was, however, he thought it was not greater than

that which Mr. Atkinson had now attained in being appointed Chairman of the Royal Society of Arts.

Many distinguished men had held that position, but from his long knowledge of Mr. Atkinson's ability, tact and accomplishments generally, he knew that he would maintain the high traditions and prestige of the Society, and that the work for which it had been formed would be worthily carried on.

SIR ROBERT HADFIELD, Bt., D.Sc., F.R.S., in seconding the resolution of thanks, said all the members would be familiar with the valuable work done by Mr. Atkinson during his long career, and his Address contained a fascinating description of what had happened during the period it covered. The Society was greatly indebted to him for the care and pains he must have taken in preparing it.

Reference was made in the Address to wireless matters. One thing which he himself was greatly interested in was the use of high frequency current for the melting of steel. His firm was now melting steel by that very remarkable method. The crucible was filled with the metal it was desired to melt, and in about three-quarters of an hour the steel became fluid, without any apparent expenditure on fuel, apart from that consumed in the far-distant power house. That was a very remarkable result, and he ventured to predict that in the not far distant future the very highest qualities of steel would be melted entirely in that way.

Mr. Atkinson had been kind enough to refer to some work which he (Sir Robert) had done on the employment of silicon steel for transformers, in the testing of which he had received great help from his friend Sir Alfred Ewing, whom he was glad to see present that evening. The first transformer made of that steel had been in use for something like twenty-five years, and the Sheffield Corporation were now effecting great economies by the use of that steel.

There was one point on which some assurance from the Chairman would be welcome. Remarkable developments were now taking place in the spreading of electric energy over our little island, and it was to be hoped that this could be done without spoiling our magnificent scenery.

The vote of thanks was carried unanimously.

The CHAIRMAN, in acknowledging the vote of thanks, referred to Sir Robert Hadfield's last remark and recalled that when the Forth Bridge was built people termed it a vile and hideous structure, whereas to-day everybody had been mentally trained sufficiently to realise that it was one of the most wonderful sights in the world. Though personally he was a cable-maker, and would like to see current conveyed underground, he was not one of those who believed that the imposing towers which were being constructed, with the long stretches of parallel wires between them, would spoil the countryside ; ultimately, he thought, it would be realised that they had a beauty of their own, as having behind them something of great meaning in our social and industrial life.

He had brought with him several objects of great historical interest. One was the first tumbler switch ever made. The tumbler switch was an entirely British product, and was hardly used anywhere else in the world. He had also the first bayonet cap lamp holder ever made. One of the inventions which enabled very great difficulties in dynamo design and use to be overcome was the use of carbon brushes, and he had brought with him a piece of the very first carbon brush ever made and used, made by Professor George Forbes, who, he was pleased to say, was still living, and he believed still lecturing every year in Glasgow on astronomy. He had also a piece of the first

high pressure cable ever made. All those four things were British inventions and British products, and had never been altered very much since the time they were first invented.

COLONEL R. E. B. CROMPTON, C.B., R.E., who was received with applause on rising, at the invitation of the Chairman, to address the meeting, said he could be of use chiefly as showing that the study of electrical development did not kill one. The number of past Presidents of the Institution of Electrical Engineers who were still alive and well was remarkable. The study of electrical phenomena was so interesting, and tended to develop a soul in a man which was quite different from the soul of the average engineer engaged in other branches of engineering science, that it seemed to prolong life!

He had listened with the greatest interest to the Chairman's Address, which was substantially correct. It was curious to see in the daily papers so many extraordinary errors as to electrical work in the early days. For instance, in talking about the new lighting of the Savoy theatre, with its thousands of lamps, the papers said "What a contrast with the early days, when there were but twelve bulbs!" No man, however, would be such an idiot as to think he could light a theatre with twelve bulbs.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, NOVEMBER 25..Actuaries, Institute of, Staple Inn Hall, Holborn, W.C. 5 p.m. Mr. H. J. Tappenden, "A Valuation of Non-Participating Policies without Classification."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Discussion on "Wooden Poles for Overhead Transmission Lines and their Preservation." Opened by Mr. W. F. Highfield.

University of London, at King's College, Strand, W.C. 5.30 p.m. Dr. H. C. Barnard, "The Education of Girls in France under the Ancien Régime." (Lecture II.)
At King's College, Strand, W.C. 5.30 p.m. Mr. P. L. Witherby, "The Making of 'The Times.'"
At King's College, Strand, W.C. 5.30 p.m. Prof. H. Zickendraht, "Scientific Radio Research in Switzerland." (Lecture IV).
At the London School of Economics, Houghton Street, W.C. 4.30 p.m. Mr. E. H. Warmington, "The Debt of Mediæval Explorers to Ancient Discoverers." (Lecture II).
At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. P. Vaucher, "La Sorbonne."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. Dr. W. R. Rickmers, "The Alai-Pamirs, a Geographical Background of Oriental Studies." (Lecture I.)
At University College, Gower Street, W.C. 2 p.m. Prof. H. R. Spencer, "Medicine in the Days of Shakespeare."
At University College, Gower Street, W.C. 5.30 p.m. Miss E. J. Davis, "How London became the Capital of England." (Lecture II).

TUESDAY, NOVEMBER 26..Anthropological Institute, at Burlington House, W. 8.30 p.m. Baron Erland Nordenskiold, "The American Indian as an Inventor." (Huxley Memorial Lecture).

Electrical Engineers, Institution of, at Armstrong College Newcastle-on-Tyne. 7 p.m. Captain P. P. Eckersley, "Broadcasting by Electric Waves." (Faraday Lecture).
At the Hotel Metropole, Leeds. 7 p.m.
At the Engineers' Club, Manchester. 7 p.m. Lieut.-Colonel S. F. Monkhouse and Mr. L. C. Grant, "The Heating of Buildings Electrically by means of Thermal Storage."
At the University, Nottingham. 6.45 p.m. Messrs. J. H. Smythe and F. G. Weeks, "Low Temperature Carbonization of Fuel with special reference to its Combination with the Production of Electricity."

Marine Engineers, Institute of, 85-88 The Minories, E.C. 6.30 p.m. Mr. A. J. Evans, "The Origin and Development of Heavy Oil Engines."

Metals, Institute of, at the Chamber of Commerce, Birmingham. 7 p.m. Mr. G. W. Woolliscroft, "The Modern Development of the Steam Locomotive."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1801. Lecture VII. Muscovy."
King's College, at 40 Torrington Square, W.C. 5.30 p.m. Dr. J. Krzyzanowski, "The Polish Novel in the 19th Century. Lecture VI. Eliza Orzeszkowa, the Painter of her Country."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. Dr. W. R. Rickmers, "The Alai-Pamirs, a Geographical Background of Oriental Studies." (Lecture II.)
At University College, Gower Street, W.C. 6.30 p.m. Mr. E. T. Elbourne, "Engineering Management." (Lecture III).
At Westfield College, Hampstead, N.W. 5.15 p.m. Prof. O. Elton, "Spenser."

WEDNESDAY, NOVEMBER 27..Automobile Engineers, Institution of, at the Engineers' Club, Manchester. 7 p.m. Mr. F. R. Banks, "The High-Speed Compression-Ignition Heavy-Oil Engine."

Egypt Exploration Society, Burlington House, W. 8.30 p.m. Dr. John Johnson, "The Search for Lost Literature in the Rubbish Heaps of Egypt."

Electrical Association for Women, 46 Kensington Court, W. 3 p.m. Mr. E. E. Sharp, "Some Electrical Experiences in Australasia."

Eugenics Society, at Burlington House, W. 8.30 p.m. Mrs. C. B. S. Hodson, "Sterilization and Social Ideals."

Historical Society, at 22 Russell Square, W.C. 5 p.m. Sir Richard Lodge, Presidential Address, "Thomas Frederick Tout: A Retrospect of Two Academic Careers."

Physics, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Dr. C. H

Lander, "Physics in Relation to the Utilization of Fuel."

Public Health, Institute of, 37 Russell Square, W.C. 4 p.m. Prof. Dr. S. L. Cummins, "Some Aspects of the Tuberculosis Problem."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. R. R. Gates, "The Contribution of King's College to the Advancement of Learning during the Century 1829-1928. Lecture VIII—The Sciences of Life."
At King's College, Strand, W.C. 5.30 p.m. Madame Aino Kallas, "Modern Esthonian Literature Lecture II —Gustav Suits."
At King's College, Strand, W.C 5.30 p.m. Prof. H. Zickendraht, "Scientific Radio Research in Switzerland." (Lecture V).
At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture VIII on "Office Machinery."
At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Mr. A. Lloyd-James, "Accent as an Element in Speech."
At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Lirica del Paradiso." (Lecture IV)
At University College, Gower Street, W.C. 5.30 p.m. Mr. L. McColvin, "Some Aspects of the Future of Public Library Work."
At University College, Gower Street, W.C 5.30 p.m. Mr. A. M. Wijk, "The Reformation Period in Sweden" (Lecture I).

THURSDAY, NOVEMBER 28.. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Squadron-Leader H. M. Probyn, "Flying and Maintenance from the Owner's Point of View"

Automobile Engineers, Institution of, at the Y.M.C.A. Hall, Newcastle-on-Tyne 8 p.m Mr. A. Healey, "The Pneumatic Tyre in Heavy Transport."

Electrical Association for Women, 46 Kensington Court, W. 7 p.m. Mr. H. Bourne, "The Construction, Use and Maintenance of Electric Kettles, Toasters, Irons and other Small Apparatus"

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. H. W. Taylor, "Voltage Control of Large Alternators."

Historical Society, at 22 Russell Square, W.C 5.30 p.m. Prof. Dr. Ernest Barker, "Islam and the Crusades"

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Ralph Edwards, "The Dining Table."

Mechanical Engineers, Institution of, at the Engineers' Club, Manchester. 7.15 p.m. (1) Mr. Francis Hodgkinson, "Journal Bearing Practice." (2) Mr. R. O. Boswall, "Bearings."
At the South Wales Institute of Engineers, Cardiff. 6.30 p.m. Prof. H. L. Callendar, "Critical Relations between Water and Steam." (Thomas Hawksley Lecture).

North East Coast Institution of Engineers and Ship builders, at the Mining Institute, Newcastle-on-Tyne 6 p.m. Mr. G. S. Baker, "Wake"

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Eccles, "Montaigne" (in French). (Lecture VIII).
At King's College, Strand, W.C. 5 p.m. Dr. W. Robson, "Protein Metabolism." (Lecture III).
At King's College, Strand, W.C. 5.30 p.m. Mr. I. L. Evans, "Austria in the Eighteenth Century." (Lecture III).
At King's College, Strand, W.C. 5.30 p.m. Mr. G. Shaw, "The Story of Descant."
At King's College, Strand, W.C. 5.30 p.m. Dr. J. A Williamson, "The Cabots and the Discovery of the New World." (Lecture III).
At the School of Oriental Studies, Finsbury Circus, E.C. 5.30 p.m. Dr. W. R. Rickmers, "The Alai-Pamirs, a Geographical Background of Oriental Studies" (Lecture III).
At University College, Gower Street, W.C. 5.15 p.m Prof. J. E. G. de Montmorency, "Momentous Lawsuits and Trials in various Countries from Classical to Modern Times" (Lecture III).
At University College, Gower Street, W.C. 5.30 p.m. Prof. W. M. Dixon, "England, The Bible, and Shakespeare." (Lecture V).

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr S. C. K. Smith, "Painters of the Norwich School."

FRIDAY, NOVEMBER 29.. Chadwick Public Lecture, at the College of Medicine, Newcastle-on-Tyne. 8 p.m. Prof. A E. Boycott, "The Causes of Cancer."

Junior Institution of Engineers, 39 Victoria Street, S.W 7.30 p.m. Mr. W. C. Freeman, "Modern Welding Systems and Applications."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Open Debate on "The Registration of Reliable Tests of Power-Plant Machinery." Introduced by Mr R. H. Parsons.

University of London, at King's College, Strand, W.C. 5.30 p.m. Rev. E. I. Fripp, "Shakespeare's Spelling"
At King's College, Strand, W.C. 5.30 p.m. Prof F. H. Marshall, "Two Mediæval Greek Romances."
At King's College, Strand, W.C. 5.30 p.m. Prince D S. Mirsky, "The Russian Drama. Lecture VII—Chekhov."
At King's College, Strand, W.C. 5.30 p.m. Prof H. Zickendraht, "Scientific Radio Research in Switzerland." (Lecture VI).
King's College, at 40 Torrington Square, W.C. 5.30 p.m. Dr. O. Odložilík, "Outlines of Czechoslovak History. Lecture II—The Czechs and Slovaks in the Middle Ages"
At University College, Gower Street, W.C. 5.30 p.m. Prof. W. M. Dixon, "England, The Bible, and Shakespeare." (Lecture VI).

SATURDAY, NOVEMBER 30.. L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. H. N Milligan, "The Hydra in Fact and Fiction."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4019 *FRIDAY, NOVEMBER 29th, 1929* VOL LXXVIII

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

NOTICES

NEXT WEEK

MONDAY, DECEMBER 2nd, at 8 p.m. (Cantor Lecture.) E. G. RICHARDSON, B.A., Ph.D., D.Sc., Lecturer at University College, "Wind Instruments from Musical and Scientific Aspects." (Lecture III).

Demonstrations will be given on the various instruments.

WEDNESDAY, DECEMBER 4th, at 8 p.m. (Ordinary Meeting.) HARRY H. PEACH, Hon. Secretary, Council for the Preservation of Rural England Exhibition Committee, "The Advertiser and the Disfigurement of Town and Countryside: Criticisms and Suggestions" SIR LAWRENCE WEAVER, K.B.E., will preside.

The paper will be illustrated with lantern slides.

THIRD ORDINARY MEETING

WEDNESDAY, NOVEMBER 20th, 1929. MR. ROGER E. FRY in the Chair. A paper entitled "Urban and Rural Amenities" was read by MR. P. MORLEY HORDER, F.S.A. The paper and discussion will be published in the *Journal* at an early date.

CANTOR LECTURES

MONDAY, NOVEMBER 25th, 1929. SIR RICHARD A. S. PAGET, Bt., in the Chair. MR. E. G. RICHARDSON, B.A., Ph.D., D.Sc., delivered the second of his course of three lectures entitled "Wind Instruments from Musical and Scientific Aspects." The lectures will be published in the *Journal* during the Christmas recess.

PROCEEDINGS OF THE SOCIETY

SECOND ORDINARY MEETING

WEDNESDAY, NOVEMBER 13TH, 1929

MR. CHARLES VERNON BOYS, F.R.S., in the Chair

The following paper was read:—

NEW DEVELOPMENTS IN HYDRAULIC PNEUMATIC ENGINEERING

By J. O. BOVING

The particular aspect of hydraulic engineering which will be discussed here is the direct conversion of water power into air power, and *vice versa*. A good deal of research and test work has been carried out during the last five years and some new ground has been broken.

The various systems and developments referred to hereafter have been called "Hydrautomats," indicating hydraulic automatic apparatus serving a diversity of ends.

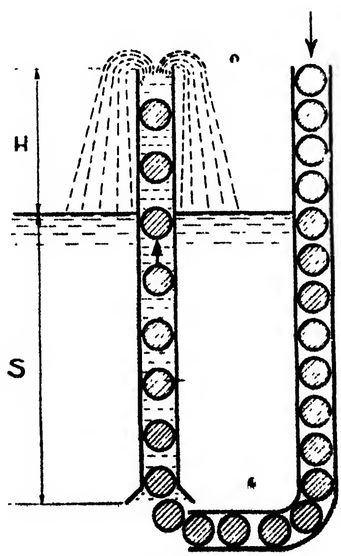

FIG. 1.

A stone falls to the ground because it is heavier than air. A piece of cork which is introduced under water will speedily rise to the surface, and the water will bulge upwards above it. We could carry out an experiment as shown by Fig. 1, introducing suitable pieces of cork at the bottom of a pipe immersed in water,

and the effect would be that the cork pieces would carry the water in the pipe higher and higher, and fresh water would enter at the bottom.

To attain a certain lift, sufficient cork must be introduced to make the combined weight of the cork and the water in the rise pipe, which has a length $S + h$, equal to the weight of water only in a tube of equal diameter and of a length S.

If we introduce air under suitable pressure, instead of cork, we have an *air*

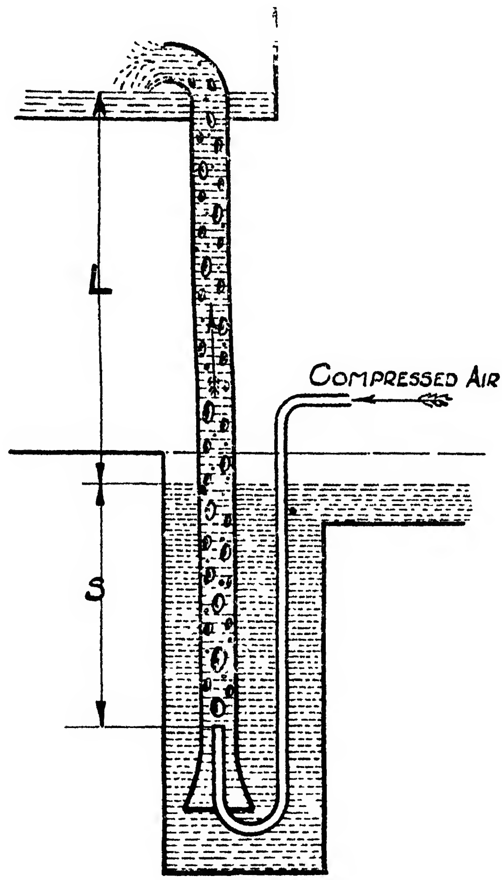

FIG. 2.

lift pump (Fig. 2), well known to engineers, but not very well understood, and consequently not in use as much as this exceedingly simple and reliable contrivance deserves to be.

If we were to imagine the air being introduced as minute bubbles, so that the rise pipe would be filled with an emulsion of water and air, then we could talk of the specific gravity of this emulsion (g) as related to that of water (1) as $\frac{g}{1} = \frac{S}{S+h}$

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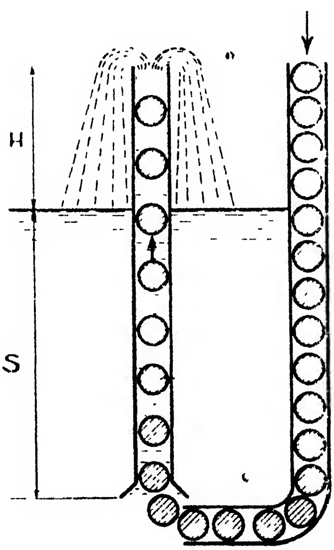

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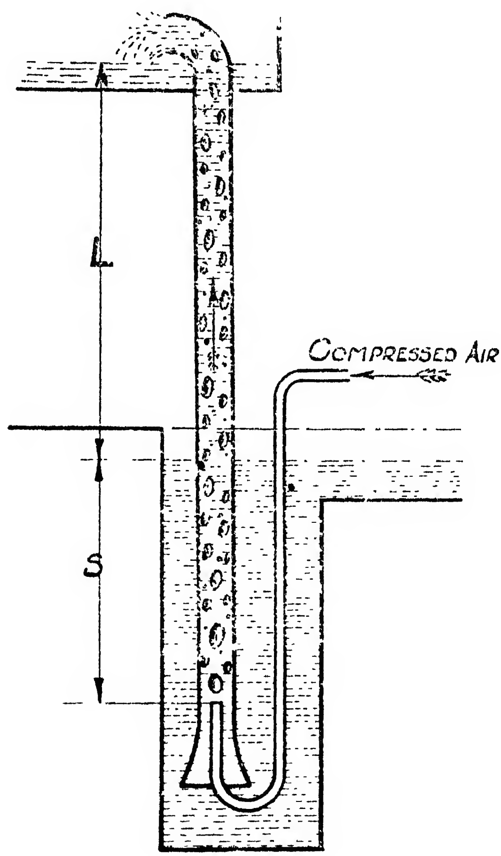

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In practice the problem is not as simple as this. It is not possible to divide up the air in such minute bubbles, and the larger the bubbles are, the more elusive they become. If we go back to Fig. 1, it is evident that if the cork balls are as large as the pipe very little slippage could take place, and the individual cork balls would patiently carry their allotted water burden upwards.

The air bubbles, on the other hand, try to escape this desired and important duty, slip sideways, or become elongated vertically so as to sneak upwards against lessened resistance, with disastrous results to efficiency. This efficiency is further decreased by the turbulence caused by the unruly air, whereby not only great internal friction is set up, but the friction against the pipe walls is also increased.

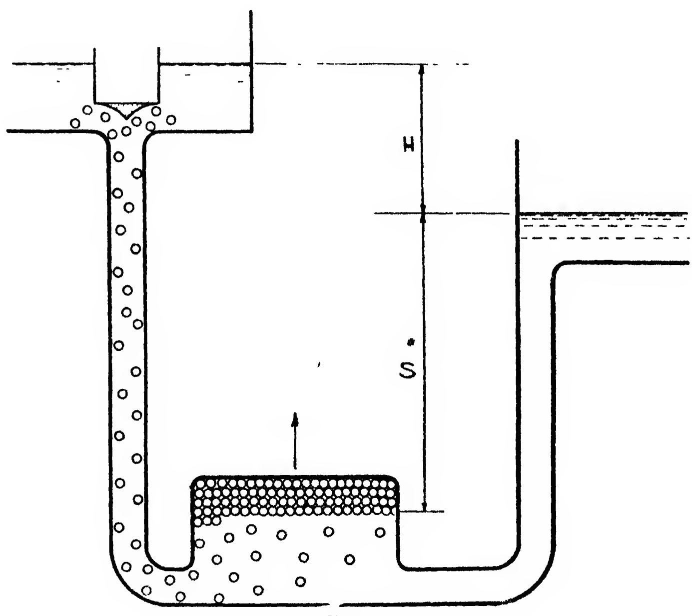


FIG. 3

Careful tests and experiments have, however, shown that by proper designing of the air and water inlets, correct dimensioning of the pipes for a given duty, and by using suitable air pressure, the unruly bubbles can be tamed to a great extent, and efficiencies well over 50 per cent. may be obtained.

Let us now reverse the process illustrated by Fig. 1 and consider an experiment as indicated by Fig. 3. Here we have a head of water (h), and the water is allowed to flow through a down cast pipe, a collector tank, an upward pipe, and away to the tail race. If there were no obstruction in the path of the water, it would flow through the system at great velocity, and all the energy of the fall converted to velocity would be dissipated in internal and external friction, and thus transformed into heat. Now assume that we introduce at the intake mouth a stream of small cork balls.

long as the velocity of the water is higher than that corresponding to the buoyancy of the balls, these will be carried downwards with the water until they reach the collector tank. If this is of ample dimensions, the water velocity will be low here, and the cork balls will speedily rise to the roof, and here collect, whereas the water will proceed through the upcast pipe to the tail race. The collected balls will exert an upward lift on the roof of the tank.

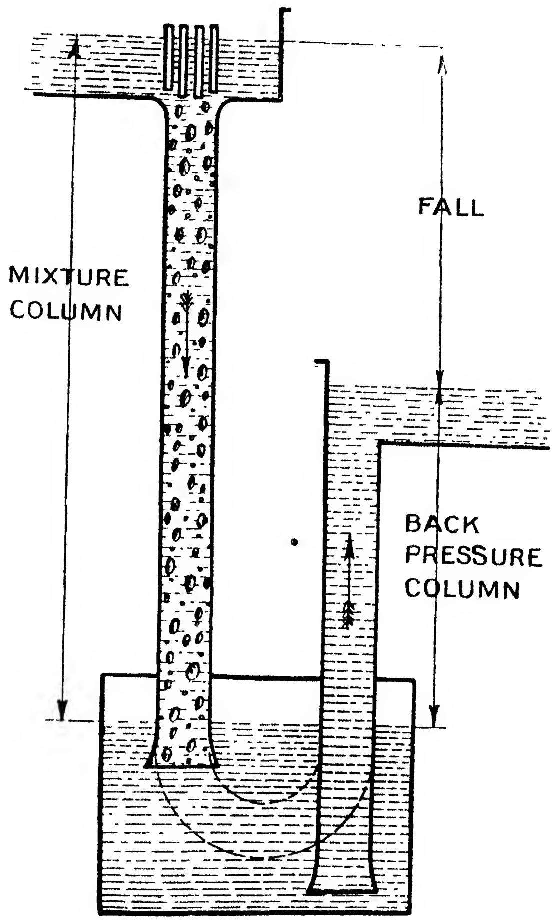


FIG. 4

If instead of cork balls we introduce air bubbles (Fig. 4) these will follow the same path as the cork, but an additional phenomenon takes place. As the bubbles proceed downwards, the water exerts an increasing pressure on them; they are squeezed smaller and smaller until liberated at the top of the collector tank. Here then we have compressed air corresponding to the static pressure of the water column (S), which balances the longer column of the down cast pipe = S + h, consisting of a mixture of water and air. And this compression is isothermal

because the heat of the compression is continuously given off to the surrounding water. Another interesting and valuable effect is added : the moisture in the air will be condensed by the colder water, resulting in dry air.

It may be asked how the air can be entangled with the water. This is not even difficult—it is almost unavoidable if the surface of the water in the head race is not too high above the down cast pipe. When a wash basin or bath is emptied, a vortex is formed and through the centre of this air is sucked down, as we all know. But it is desirable to break up the water and air, and to cause disturbances so as to reduce the size of the air bubbles, for exactly the same reasons as were given for the air lift pump.

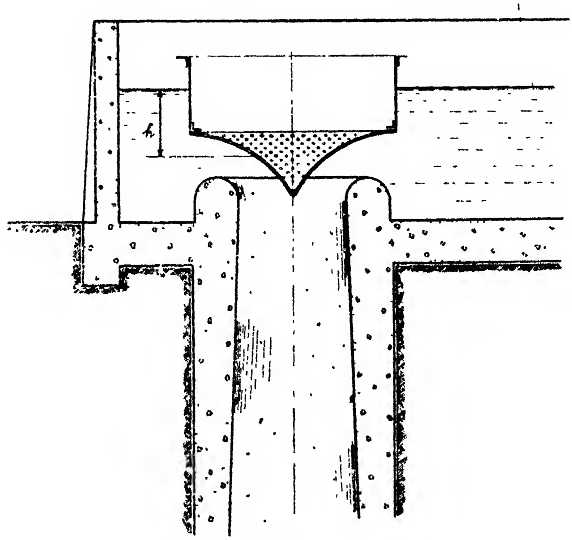


FIG. 5

An inlet and arrangements for the aspiration of air which have proved satisfactory are shown by Fig. 5. The entrance for the water is so dimensioned and shaped that the velocity here is slightly higher than the spouting speed for the head (h). Thus there is sub-atmospheric pressure on the roof of the inlet, and this being perforated with a great number of small holes, air freely enters the water at all points.

Such Hydraulic Air Compressors have been built in a simple form for centuries by blacksmiths in the Vosges and Pyrenees, providing air for their forges. During the last 30 years a number of serious installations have been built in various parts of the world, but particularly in Canada and Germany. In Canada the well-known engineer, C. H. Taylor, constructed several commercially successful plants of large dimensions. It is, however, an art that is very little known, and consequently some plants have given a poor efficiency.

The test and research work lately done in England has proved that with a correct design, and with proper attention to detail, a direct conversion of fo

pound water power into foot pound air power– isothermal compression—an efficiency from 55 per cent. to 75 per cent. can be obtained. The variation depends on the relation between the available fall and the desired compression, as well as on the size of the plant. If the same conversion were to be made by water turbines and mechanical compressors the residual efficiency would be from 35 per cent. to 50 per cent.

And what a beautifully simple apparatus the Hydraulic Compressor is, requiring no attention and subject to no wear, and thus no repairing costs.

The idea may now be carried one step further and used for rarefying air instead of compressing it. To this end an arrangement diagrammatically shown by Fig. 6 is used. The water is taken up from the head race through a syphon,

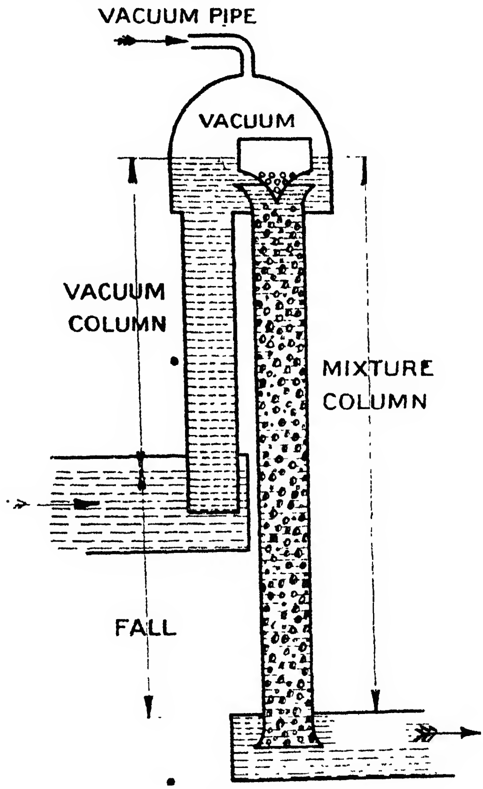


Fig. 6.

the longer leg of which dips into the tail race. Air is drawn in at the top by suitable arrangements and the degree of rarefaction is determined by the length of the shorter leg of the syphon. Obviously the rarefied air is compressed from a partial vacuum to atmospheric pressure. It is necessary to devise some priming arrangement to start the syphon and such will be described later on in connection with plants actually in operation All the observations made with reference to the

compressor are equally valid for the rarefier, with this exception—that it is obviously more difficult to entangle the rarefied thin air with its corresponding higher buoyancy. It has been found that the greatest rarefaction which can be obtained at a commercially useful efficiency corresponds to about 24ft. water column at sea level.

It became a logical development to combine the Compressor and rarefier into one unit, as shewn by Fig. 7. This demonstrates a plant built entirely in concrete, except for the inlet members for the rarefied air. From the head race the water mounts up into the syphon, and at the top of the downcast leg the air is sucked out from the hollow fish-shaped aspirator members, perforated by small holes, and the

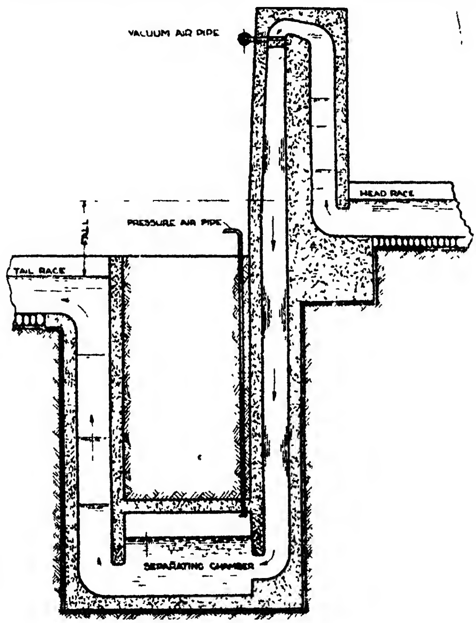


Fig. 7.

air bubbles descending with the water are now subjected to compression, first to atmospheric pressure, and then to a pressure corresponding to the difference in the level between the tailrace and the water in the separation chamber. From this the pressure air is led off by a pipe, whereas the partial vacuum is maintained in the pipe leading to the syphon aspirators.

There are several important features about this combination, eliminating some drawbacks which under certain conditions are inherent in the Hydraulic Compressor or Rarefier, when built singly. Thus in a compressor great variations in the upstream level will cause loss in efficiency. To a certain extent this may be overcome by floating air inlets, but this is a clumsy arrangement and is not practicable for large plants. Any head which is above the intake is lost, or nearly lost, and if, for example, the available working head were 10 feet, and the upper water were to rise 2 feet above its normal level, then there would be nearly 20 per

cent. loss from this cause alone. Similarly, if at a rarefier the tail race level were to rise above the normal, then the air would have to be compressed to a corresponding degree above atmospheric pressure, which work would be a clear loss. Thus we see that the rarefier is not influenced by variations in the upstream level, neither is the compressor influenced by fluctuations downstream, and the combination achieves an ideal plant.

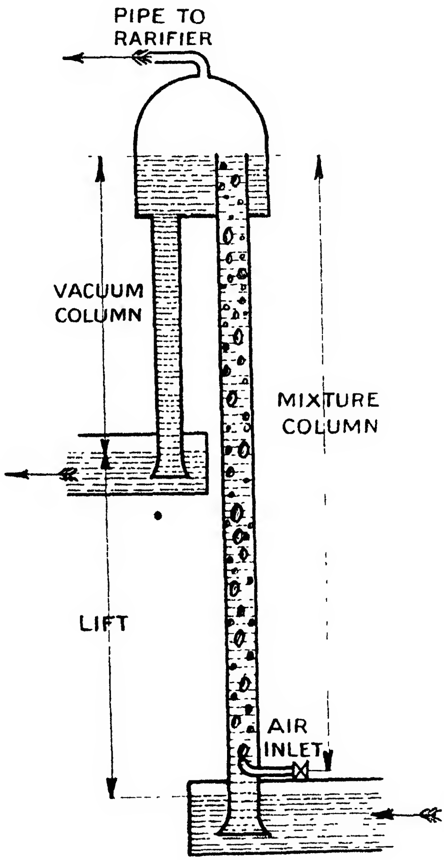


FIG. 8.

Returning to the air lift pumps, an arrangement is shown by Fig. 8, where rarefied air is used for such a plant. The apparatus forms a syphon in which the longer leg contains a mixture of water and air, and the shorter leg solid water. The two legs open at the top into a vacuum chamber, which is connected to the rarefier by a pipe. At some little distance above the lower water level atmospheric air is introduced, and will be sucked in freely, as a partial vacuum exists here corresponding to the height above the lower water level. The air will rush up into the pipe and aerate the column, causing the mixture to overflow into the

vacuum tank at the top. Here the air is sucked away to the rarefier and the water descends the shorter leg, which dips into and is sealed by the upper water level.

A rarefier and a continuous vacuum lifter are shewn side by side in fig. 9.

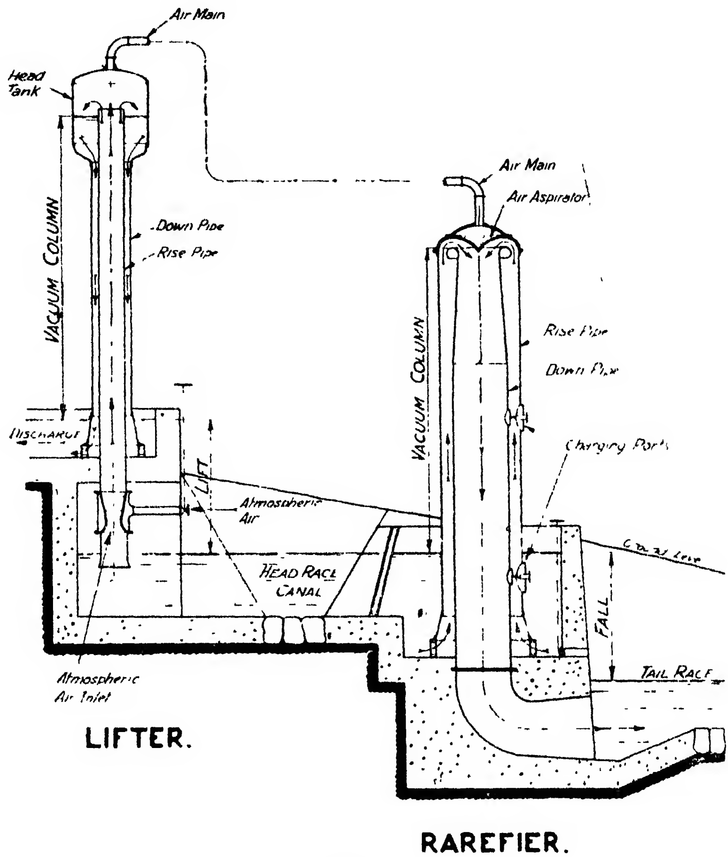
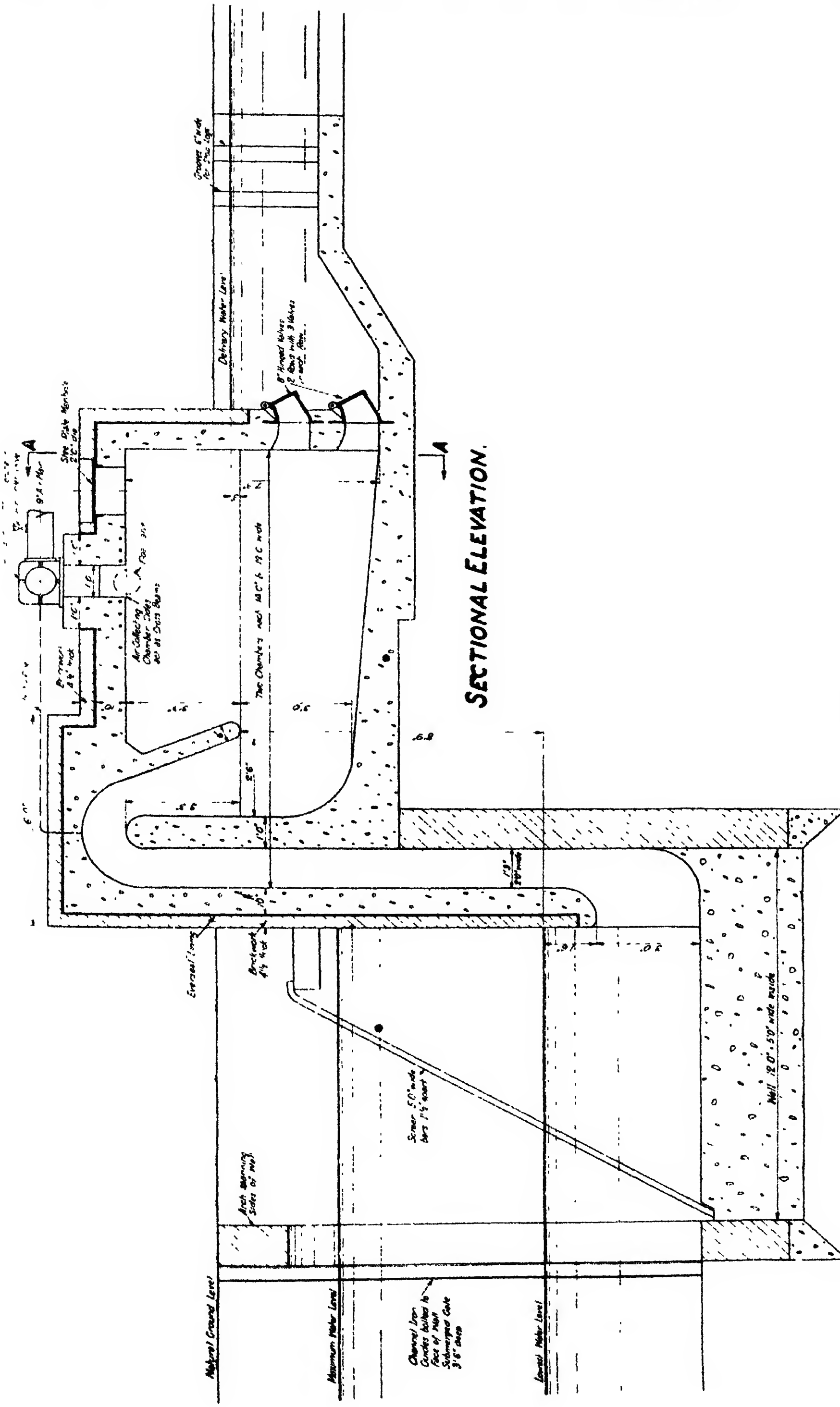


FIG. 9.

A combined pressure and vacuum air lift pump has also been designed to work in conjunction with the combined compressor and rarefier, as described above. The pressure air coming from the compressor tank is introduced at the bottom of the lift column, which carries a vacuum tank at the top, and from this the air is sucked away to the rarefier and the water descends into the upper level of the pump. Thus the same air circulates throughout the system, modified by such extra requirements as may be governed by the pressure lift, being a larger or smaller proportion of the whole than the vacuum lift.

The air lift pump constitutes an extremely simple, reliable and cheap apparatus, which deserves a very wide application, now that it can be designed to give a good efficiency. It is true that compared with other means of pumping the theoretical



SECTIONAL ELEVATION.

FIG. 10

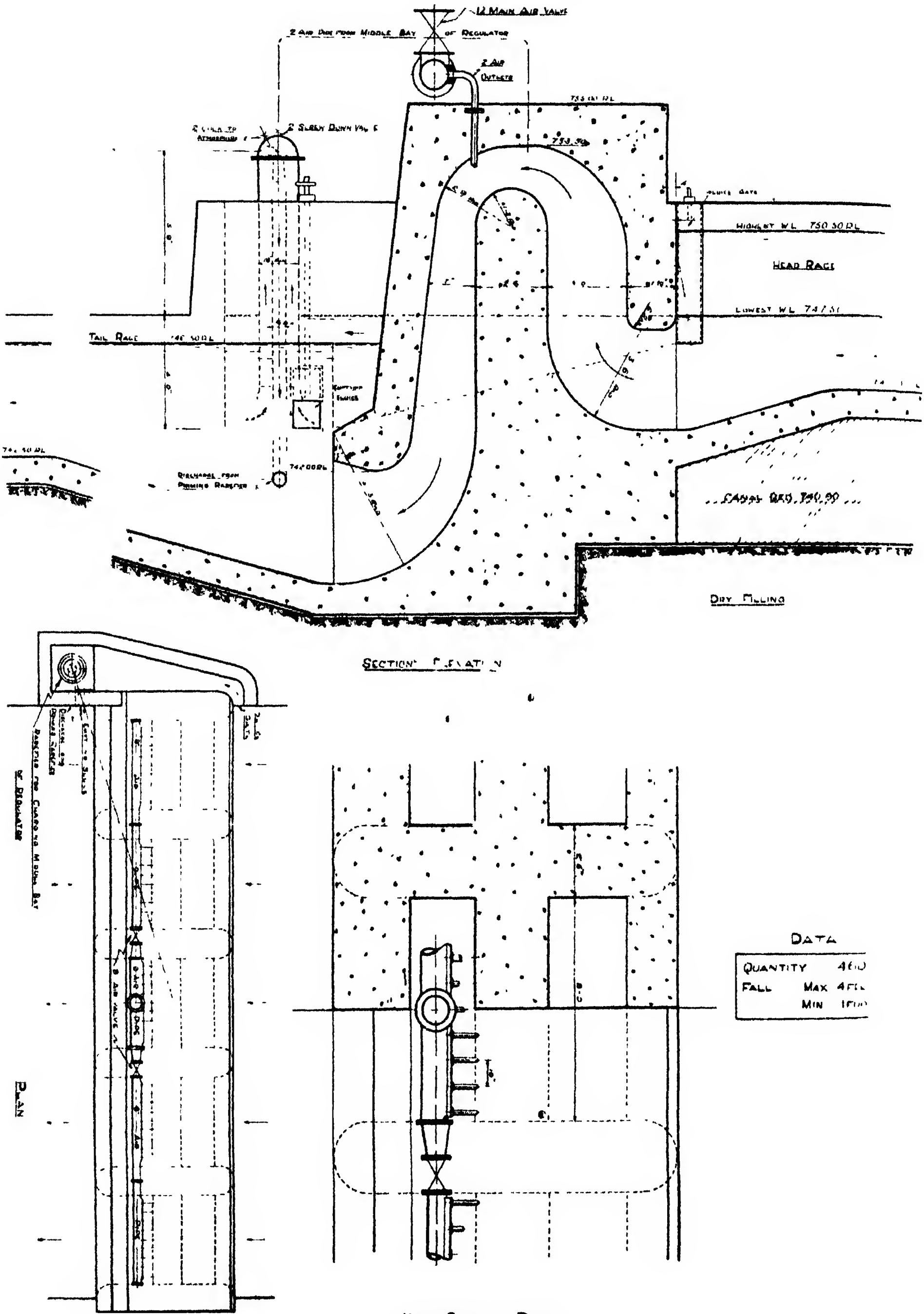

12 Main Air Valve
2 Air Pipe from Middle Bay of Regulator
2 Air Outlets
2 Sleek Down Valve
Head Race
Highest W.L. 750.50 D.L.
Lowest W.L.
Tail Race
Canal Bed 740.90
Dry Filling
Section Elevation
Plan
Half Section Plan
Data
Quantity
Fall Max
Min

FIG. 11.

efficiency is rather low, but when one considers its absolute freedom from stoppage, the absence of costs for attendance and repair, as well as its cheapness, the practical efficiency is really very high.

A pneumatic lifter of a different design and giving a higher efficiency is shewn by Fig. 10. The example demonstrates an intermittent lifter for rarefied air, but the same principle is also applicable to pressure air, whereby the lifting chamber is immersed in the water to be pumped.

The apparatus consists of a syphon lift pipe, a tank, a set of water valves, and an automatically operated change-over air valve. The system is duplicated, so that when one tank is filling the other is discharging. The air valve opens the tank to the vacuum pipe coming from the rarefier, whereby water is sucked up through the syphon until the tank is full. The air valve is now changed over, actuated by a float which is lifted by the rising water. A suitable relay movement is used to prevent the valve from sticking half way through its stroke. Atmospheric air is now introduced (whilst the vacuum is applied to the other tank) and the water flows out past the reflux valves.

A modification of the syphon rarefier has been applied to regulating the flow over a weir. The usual mode of regulation is by sluice gates of various designs and magnitude, and those who are familiar with large scale irrigation work will know how expensive, complicated, and clumsy in manoeuvring such sluice barrages are.

Fig. 11 demonstrates a " Hydrautomat " regulator which is extremely simple, cheap to build, and easy to operate. The syphon stretches right across the canal, and the centre wall provides a complete shut off for the water when the syphon does not function.

Air is introduced into the downcast leg of the syphon as shown above, for the rarefiers, and the power in the fall is dissipated by the compression work done. The more air is admitted the less water flows through, and thus by having all the air inlets coupled to a bus pipe, fitted with an admission valve, the flow of water can be regulated by controlling this valve. Such control may be effected either by hand, or automatically by a float in the upstream or downstream water level—with a view to keeping this constant. The design shows the regulator consisting of 5 bays. Two other valves are fitted on the bus pipe, and thus one, three, or five bays can be in operation, and the closest regulation of the waterflow can be effected. The priming of the syphon is effected by a small auxiliary rarefier built separately on the side of the regulator.

The above indicates in a simple way the theories and practical conditions which underlie the " Hydrautomat " developments. In the following, descriptions of some representative plants are given.

Fig. 12 is a drawing of a compressor plant built at Alston in Cumberland. The available head is 180ft. A 500ft. long pipe line conveys the water downhill to the compressor. On the top of a tower a tank is mounted, to which the pipe line is connected. The compressor pipe carries an air intake on top and dips vertically

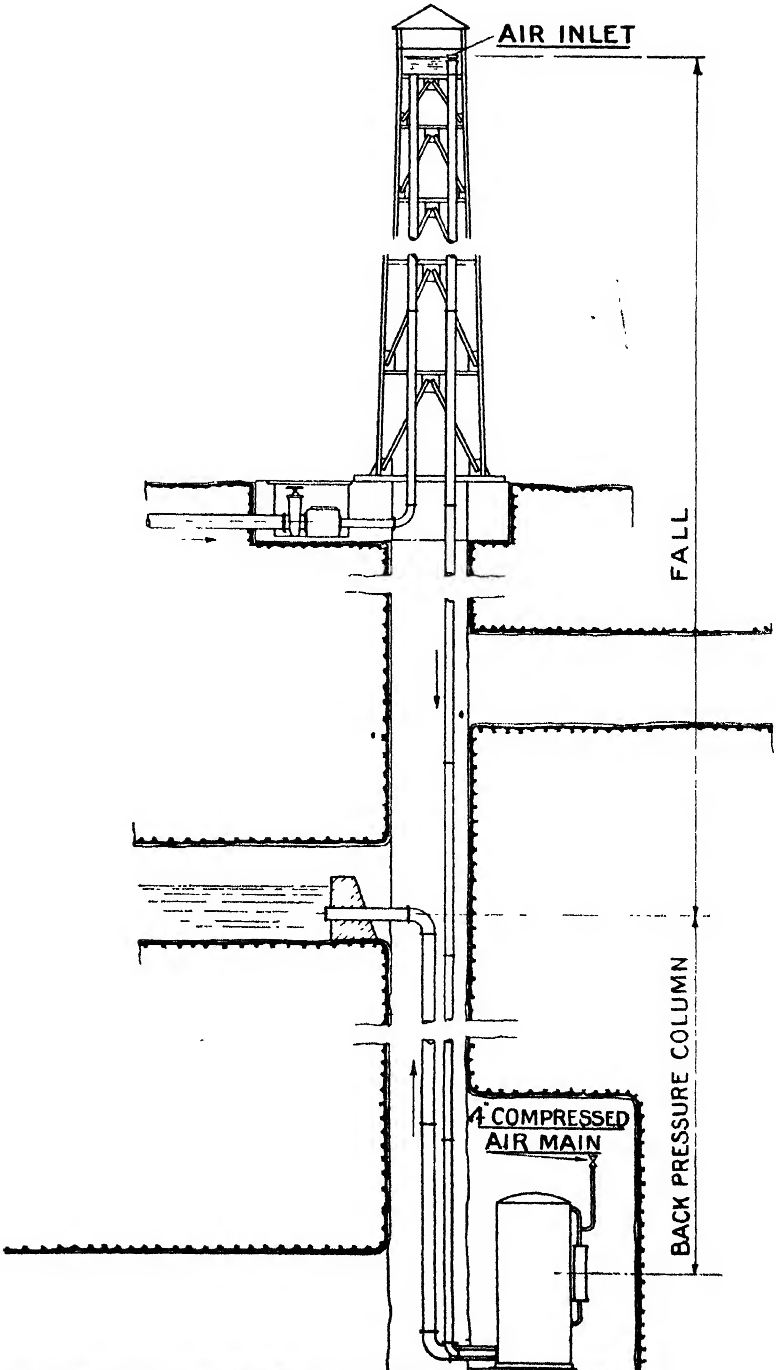


FIG. 12.

410 feet into an old disused mine shaft. At the bottom of this is an air separator built of steel. An automatic valve controls the water level inside the tank. The water rises up again 210 feet from the tank to the tail race, for which an old gallery is used which opens out further downhill.

The degree of compression corresponds to 90lbs. per square inch, and the output is 480 cubic feet of free air per minute. The efficiency is about 65 per cent. If a pelton wheel driving a mechanical compressor were used, the output would only be about 290 cubic feet of free air per minute. The compressed air is used for drills and other pneumatic tools in the mines belonging to the Vieille Montagne Zinc Company. Another similar compressor is working nearby in another mine.

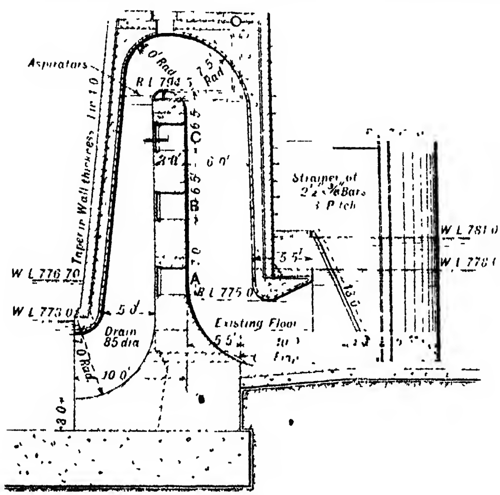


FIG 13.*

Most of the Hydrautomat water lifting work has been done in India in connection with irrigation, which in that country is carried out on a gigantic scale. Few people realise that some 40,000,000 acres are under irrigation in India. The area of arable agricultural land in England is about 10,000,000 acres. Take for example the Punjab—" the land of five rivers "—there are a dozen or more canals, each a hundred or more miles long, and each carrying an amount of water thirty or forty times greater than the summer flow of the Thames. These main canals and their branches flow over the gradually sloping plain, and at intervals there are barrages to keep up the desired water levels, thus creating low falls. At such places Hydrautomats are put in.

Wherever intensive irrigation is applied water-logging sets in sooner or later, throwing the land out of cultivation, and in the Punjab alone it is estimated that over a million acres are so affected.

A typical plant lifting water from a drainage canal in such a district will be shown. Fig. 13 is the rarefier installed at *Bambanwala* on the *Upper Chenab Canal*. The

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syphon is built of brick and re-inforced concrete, with a sealing layer so as to make the whole edifice impervious to air. The dimensions of the intake are 6ft. x 8ft. 5ins., and the water that can pass through at full velocity is about 300 cubic feet per second.

In the middle wall there are three ports which can be closed by butterfly valves. The lowest of these opens below the lowest upstream water level. In starting the syphon this valve is opened, water rushes through and splashes down into the lower level, and by this commotion a certain amount of air is entrapped and carried away to the tail race. As the whole syphon is water sealed the air becomes gradually rarefied, and the water level in the two legs begins to mount. When it reaches the next port the action gains fresh impetus and thus proceeds up to the topmost port, and finally over the crown. When the water gets this far, the syphon is filled instantaneously almost and the priming ports can be closed The apparatus is in function.

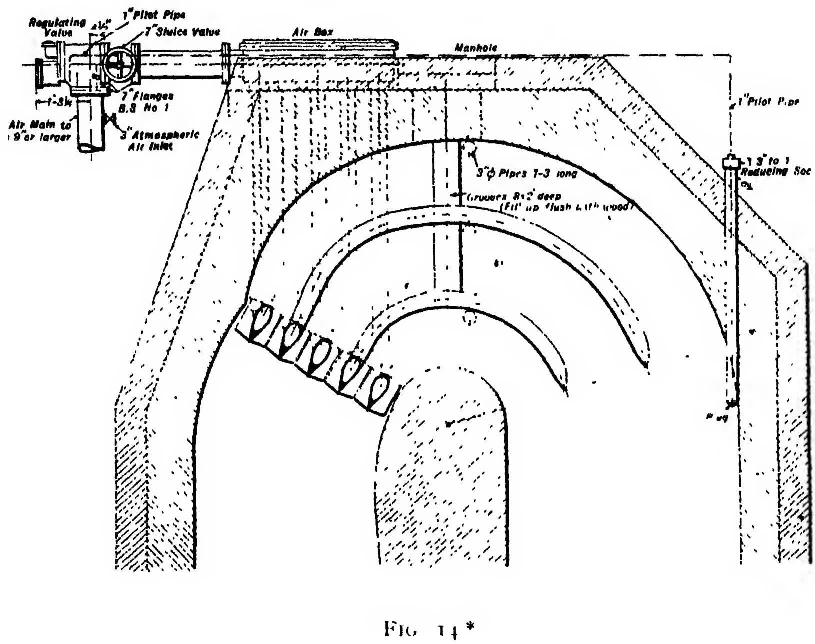

FIG. 14*

Fig. 14 is a drawing of the aspirators, which, as will be seen are hollow, and perforated with a great number of holes, through which the air is sucked into the water. The aspirators are connected to a collector and to the pipe line.

Fig. 15 shows diagrammatically a contrivance to prevent a violent inrush of air to the syphon, should the outside pipe line suddenly be opened.

This consists in principle of a float connected to a valve mounted on the air pipe line. If too much air should be drawn in by the aspirators the level in the

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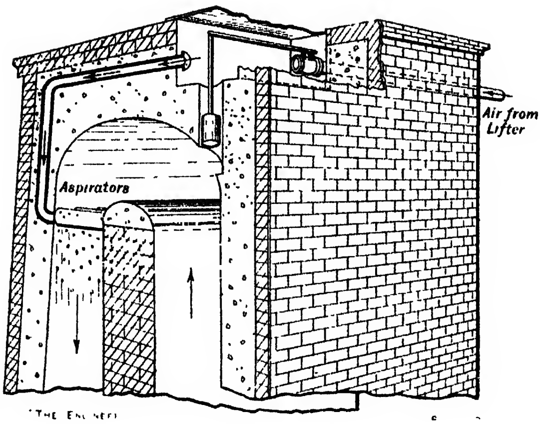

FIG. 15

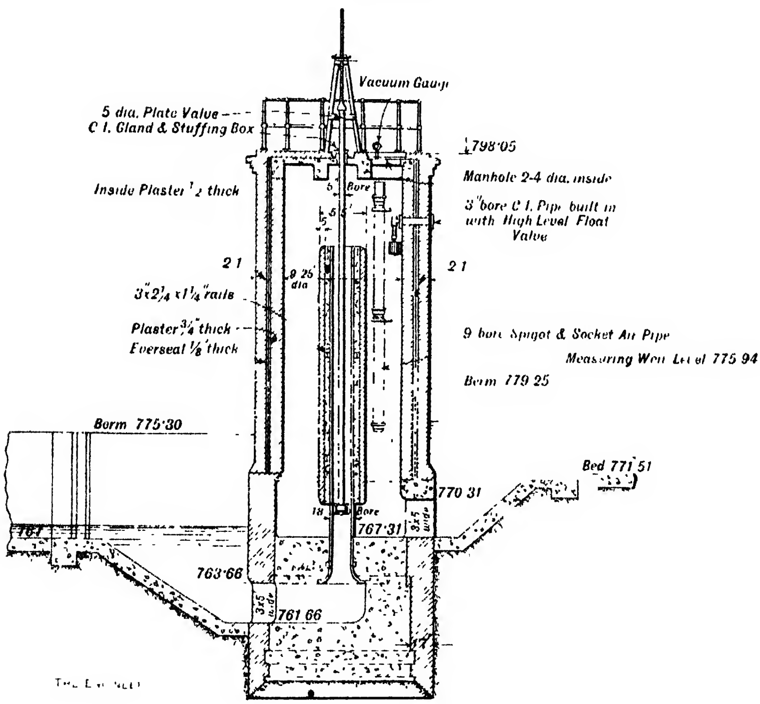

FIG. 16 *

crown of the syphon would at once tend to fall, this would influence the float, and the valve in the pipe line would be throttled.

Fig. 16 shows a section of a continuous vacuum lifter, which is operated in connection with the rarefier just described. The lifter is built as a tower in brick,

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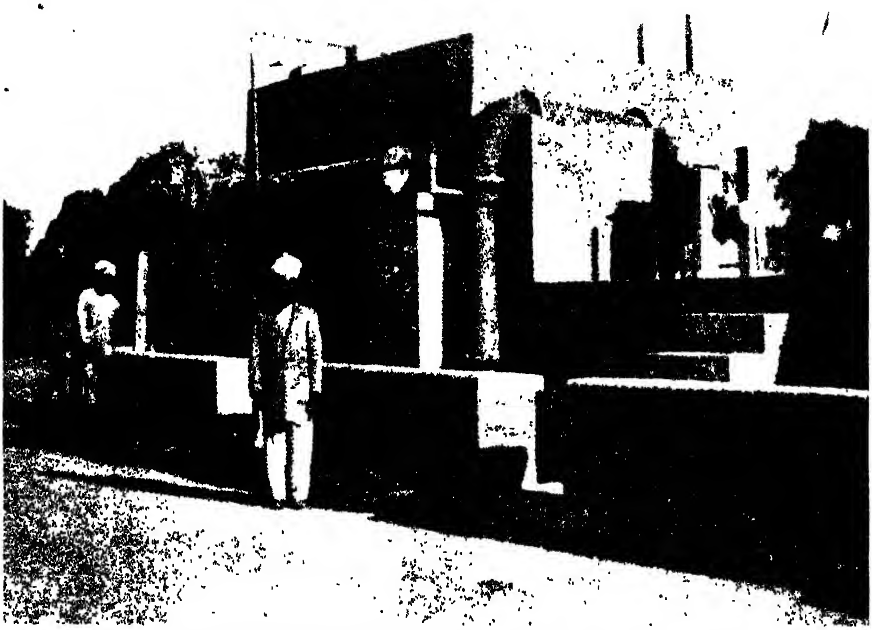
and has an air-tight sealing layer in the middle of the brick walls. There are three pumping pipes built of pre-cast concrete 18ins. in diameter. The atmospheric air is admitted through pipes which are led in from the top of the tower through the stuffing boxes, and the height of the air inlet over the lower water level can be adjusted by a manoeuvring gear from the top. This lifter pumps about 11 cubic feet of water per second, and the lift varies from 4ft. up to 8ft. The lifter is connected by a 9in. air pipe line to the rarefier, and the two sets of apparatus are about 500ft. apart. This plant drains the town of Bambanwala and some thousands of acres which had to be abandoned on account of water-logging. After six weeks of operation the ground water level had been lowered sufficiently to save the town and to bring back the land to cultivation, and the total expenditure for the plant is something like £900. There are three similar plants on the same canal.

Upper Chenab Canal, Punjab, India, shewing two Hydrautomat Rarefiers at the ends of the regulator.

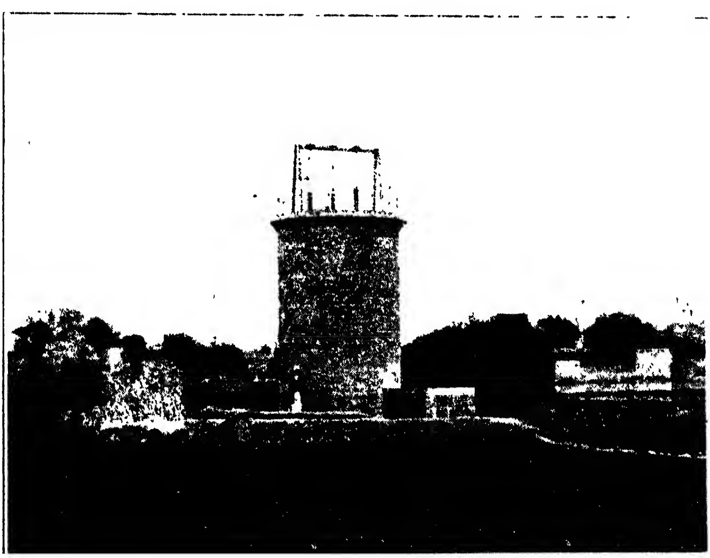
The next plant to be described is on the *Lower Jhelum Canal* in North West India, and consists of the Hydrautomat Compressor as shown on Fig. 17, to which are connected by air pipe lines 8 borehole wells, each 1000ft. apart. This plant is pumping up underground water for irrigation. The design and construction of the Compressor are rather interesting, as the whole affair is sunk as a caisson in alluvial ground, whereby the compressor pipes are formed as tubes in the very walls of the circular caisson.

As will be seen the dimensions are considerable. The diameter of the caisson is 33 feet and the depth of the shoe below the surface is 72 feet. The operating head is 8ft. 2ins. and the degree of compression is 48 feet.

The pumping plant is shown by Fig. 18. Each borehole well has two lift pipes. This method has been chosen because there are great fluctuations in the level of the underground water, and sometimes only one pump will be in operation, and at other times both, when they again may work either in parallel or in series. Each well pump has a capacity of 2 cubic feet of water per second, with a lift varying from 14ft. to 34ft.



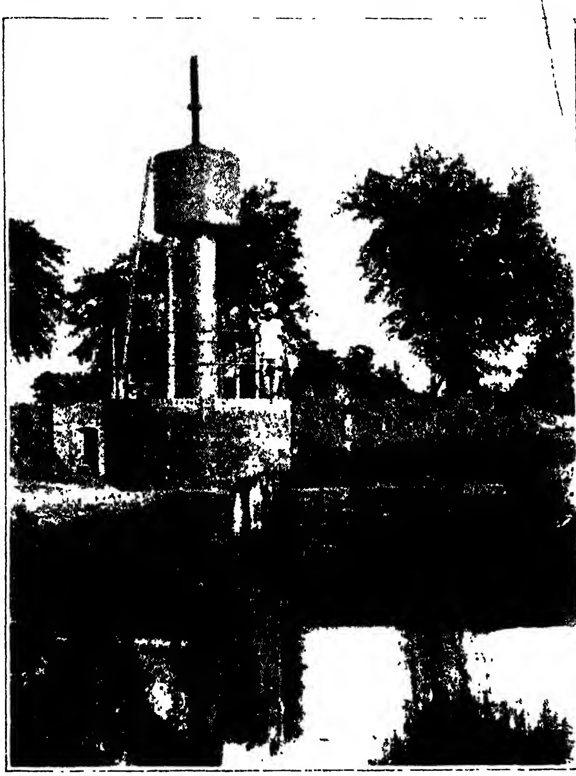
Hydrautomat Rarefier at Chianwali, Punjab, India.



Hydrautomat Lifter made in brickwork.

This plant shows how beautifully flexible the Hydrautomat system is. The compressed air can be used as power transmitted within reasonable distances, and as the apparatus is so extremely simple and rugged, and as no attention is required, the running cost is practically nil.

The next Hydrautomat to be shewn is being built on the Rio Ebro in Spain, not far from Saragossa. Here again the combination of Hydrautomat Compressor and Air Lift Pump is used, but the conditions in this case are rather difficult to meet, as the water has to be pumped up to three terraces, having levels 30ft., 45ft. and 60ft. above the river.



Hydrautomat Lifter made in Steel.

Fig. 19 shows the design of the plant. An old dam exists across the river, built by the Moors, and on the side is a millrace which is now used as an intake for the Hydrautomat. There are four compressor shafts opening out into the air separator at the bottom--all excavated in the rock, and afterwards lined with concrete. The head is only 6ft. and the available operating water about 100 cubic feet per second. The air is compressed to 15lbs. per square inch above atmospheric pressure. The water is lifted in 4 stages, each 15ft. It is necessary

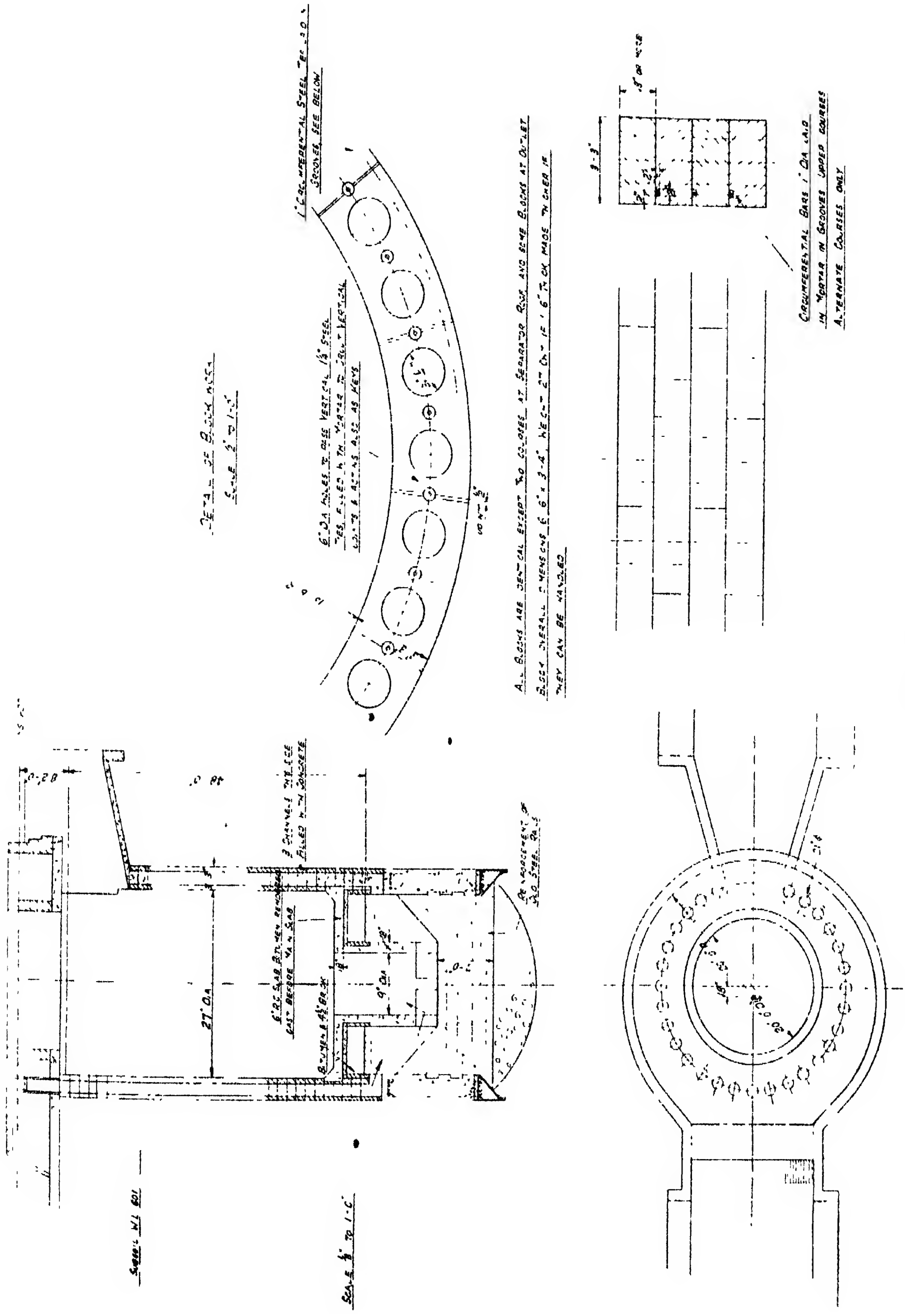


FIG. 17.

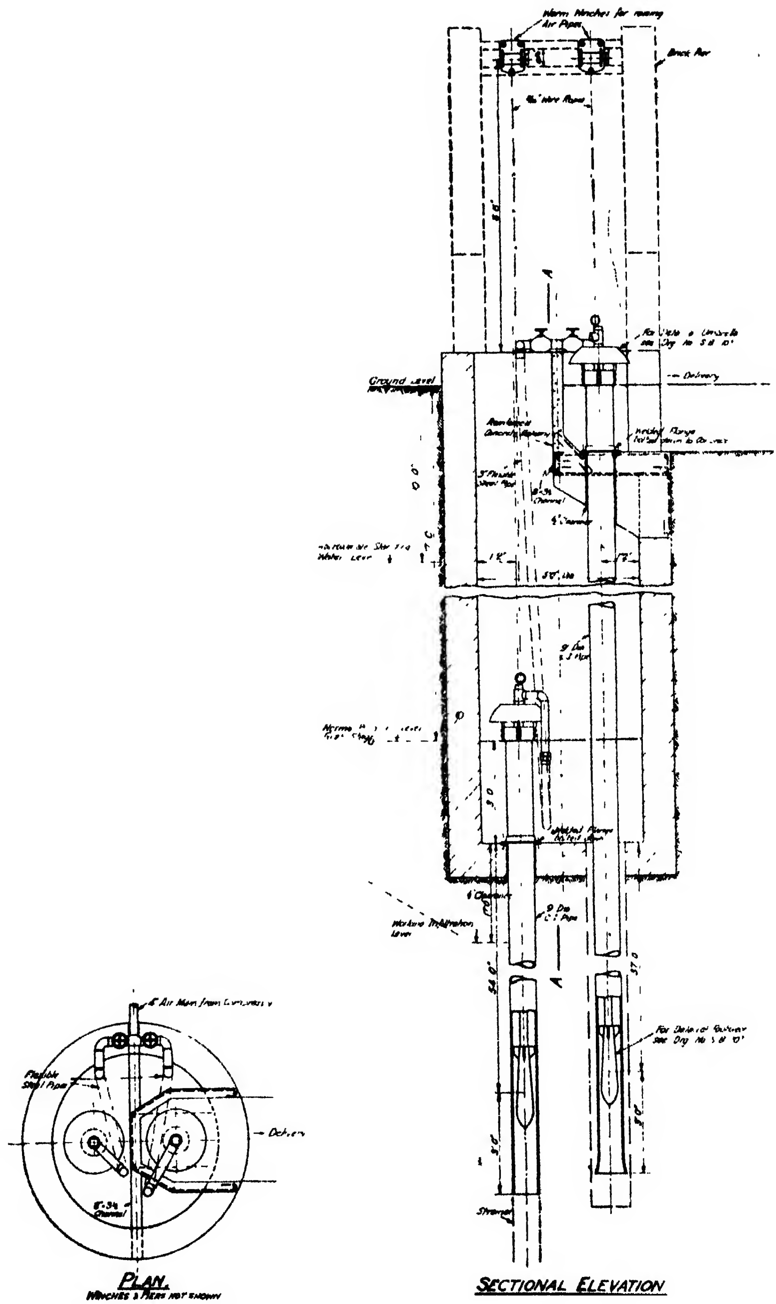

Air Pipes
Brick Pier
Ground Level
Delivery
Channel
Strainer
Flexible Steel Pipe
PLAN.
WINCHES & PIERS NOT SHOWN
SECTIONAL ELEVATION

FIG. 18.

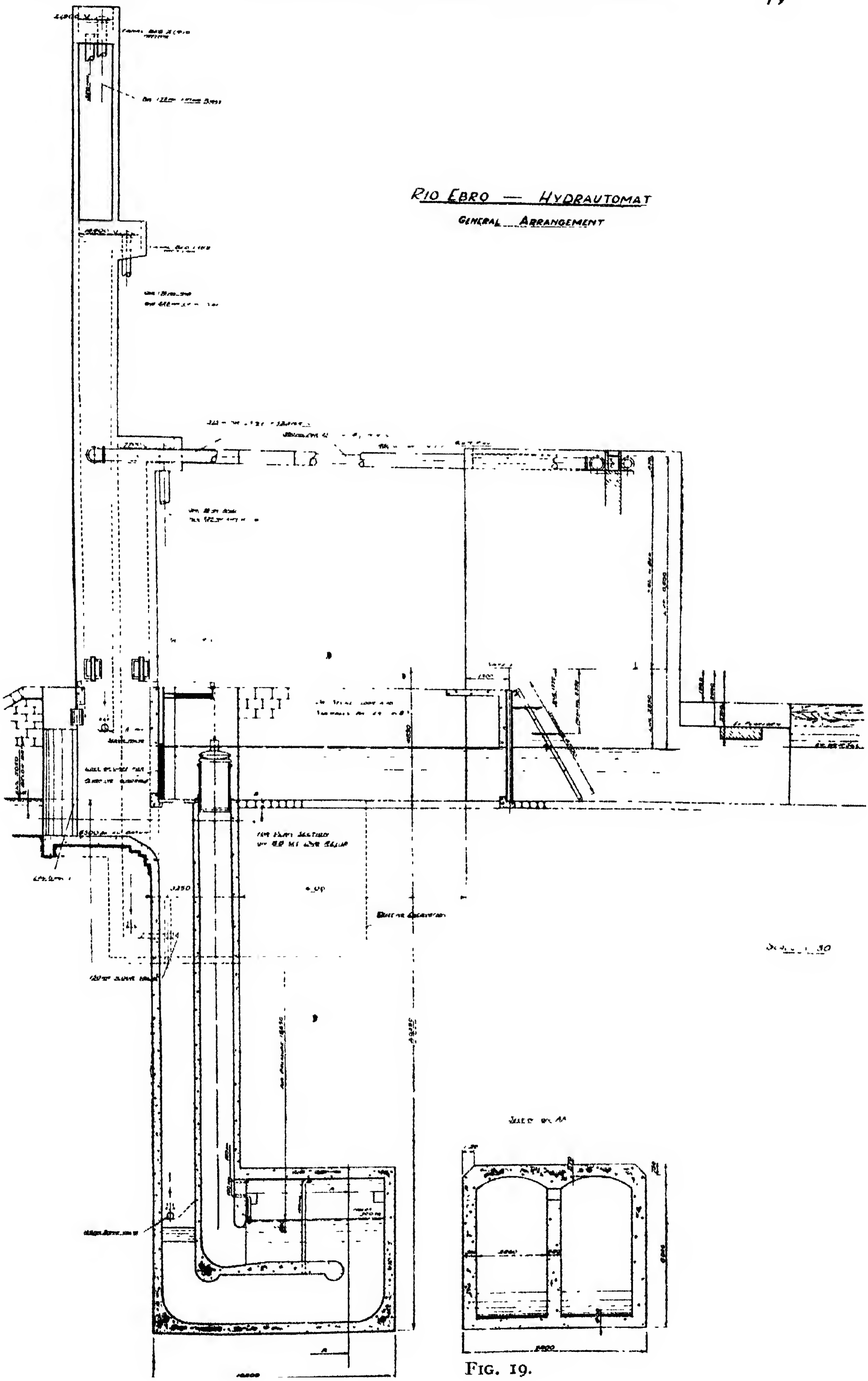


FIG. 19.

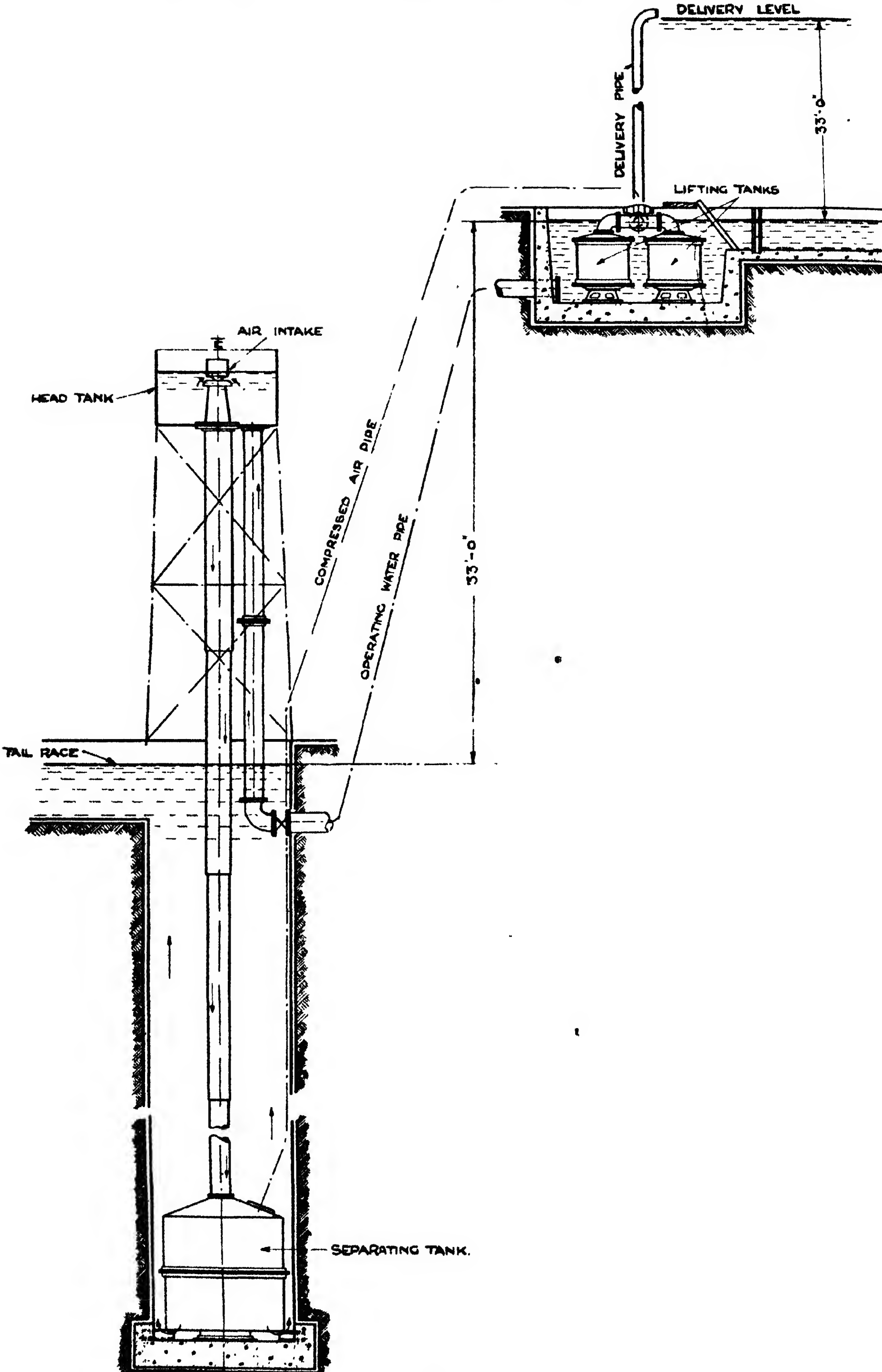

DELIVERY LEVEL
DELIVERY PIPE
33'-0"
LIFTING TANKS
AIR INTAKE
HEAD TANK
COMPRESSED AIR PIPE
OPERATING WATER PIPE
33'-0"
TAIL RACE
SEPARATING TANK.

Fig. [illegible]

to divide up the capacity into several pipes, because when the water is lifted up to the maximum height of 60ft. a correspondingly smaller amount of water can be pumped only, and in this case only one pumping pipe in each stage operates, whereas when the water is supplied to the first level, three pipes are working in parallel. The capacity of the plant is 50 gallons per second for the first stage, 38 gallons for the second stage, and 25 gallons for the highest lift. The plant is built entirely by local labour and foremen.

Fig. 20 demonstrates a combined compressor and displacement Hydrautomat as installed for a tin mine in Nigeria, where the tin is found in the alluvial deposits on the river banks, and the method of mining is to sluice down these banks with water. The rivers have a very gradual slope only, and it is therefore difficult to get the water high enough up on the bank by level channels. Such Hydrautomats as illustrated have proved very useful for the purpose. The operating head and the lift are in this case identical, namely 33ft. The compressor is built of steel pipe, and the separator tank is also in steel. The air, which has a pressure of 18lbs. per square inch, is conveyed by piping to the water lifters, which are 1400 feet away. The displacement tanks are built entirely in steel and cast iron, but the operation is the same as indicated previously. The apparatus lifts 2½ cubic feet per second.

It may be worth while to mention another development, which although not a combination of hydraulic and pneumatic action, is an offshoot of the developments described above. Fig. 21 shows a diagram of the *Static Hydrautomat* apparatus which uses directly, statically and automatically the power in a low head of water to lift a small amount of water to a great head. Thus this apparatus has the same field as the hydraulic ram, with this distinction, that it can be built for a larger capacity than the ram ; that it gives a very high efficiency under all conditions, namely, well above 70 per cent., and that it works entirely without any shock - which admittedly is a serious drawback in rams under certain conditions.

The Static Hydrautomat consists of low pressure and high pressure pistons directly connected, and an automatically operated distribution valve, sending the water into one side of the operating cylinder, whilst connecting the other side to the suction pipe which dips into the tail race. A suitable relay mechanism is provided so that it is not possible for the apparatus to stop at any dead point. The high pressure piston and cylinder work exactly as an ordinary reciprocating pump in connection with the reflux valves. This apparatus will lift water to 400 feet or more when utilising a head of 10 feet only.

In the foregoing, systems and apparatus have been described which are in successful commercial use.

There is a wide field for applying these ideas to other uses, not yet fully explored.

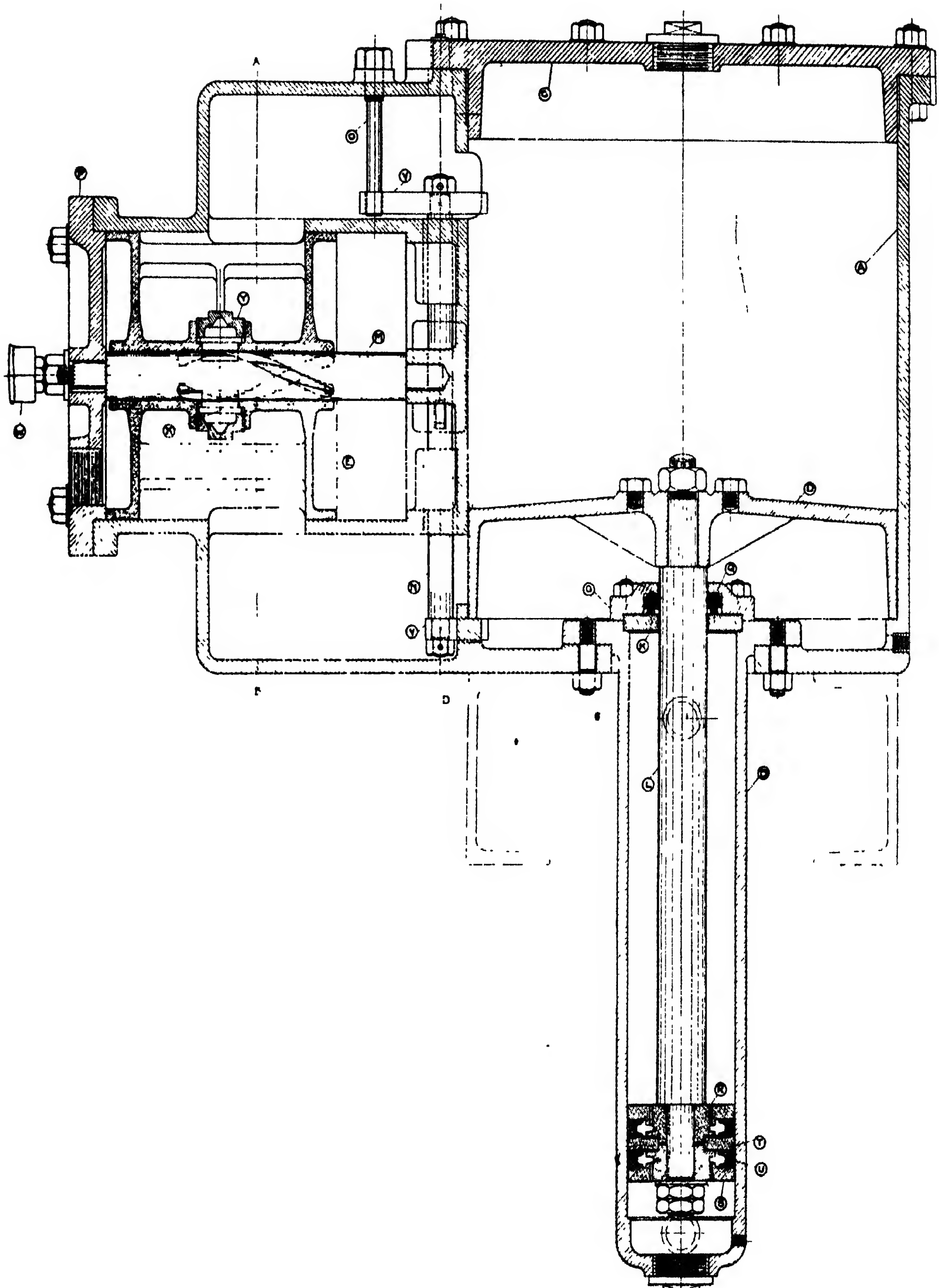


Fig. 21a.

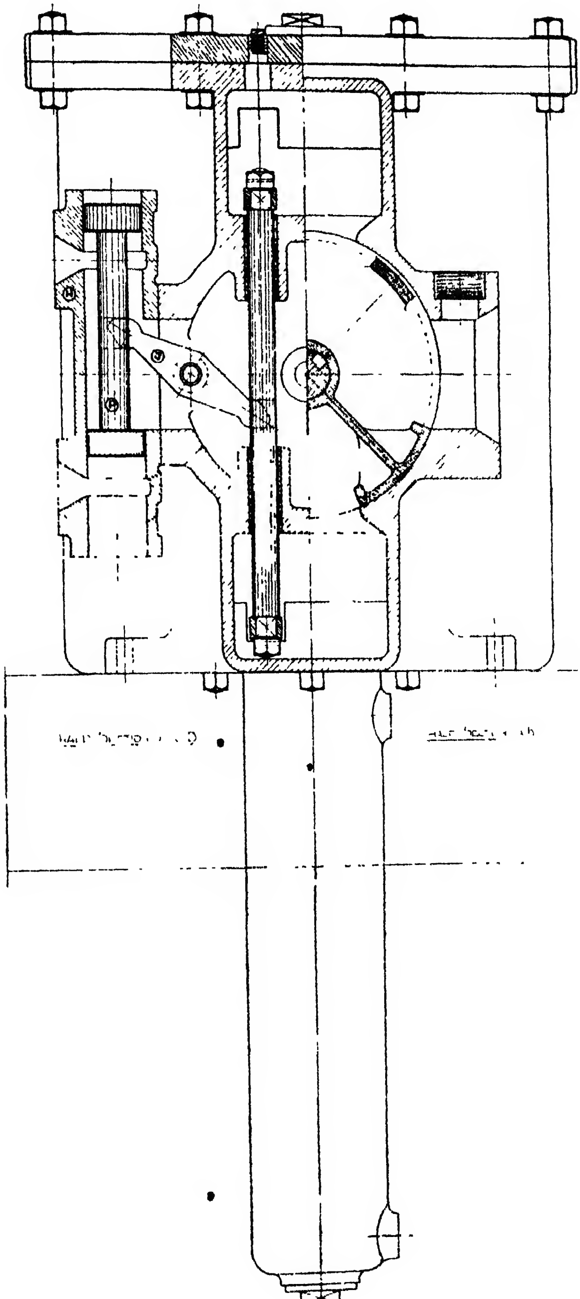


FIG 21B

DISCUSSION

SIR OLIVER LODGE, F.R.S., said that his attention was first drawn to an apparatus for raising water to a fairly high level—an apparatus brought out by his friend, Mr. T G. Allen, and named by him a " hydrautomat." This apparatus excited his interest very considerably, and he went carefully into the mechanism. It seemed to him to work very well. It had not been mentioned by the lecturer, and he gathered that it had been superseded by other devices which, if not more efficient in the ordinary technical sense, were, as the lecturer had suggested, more practically efficient from the point of view of economy in working, and so on. This apparatus differed from some of the devices described that evening in that it was static. In the last of the figures shown by the lecturer, there appeared to be some approximation to Mr. Allen's hydrautomat. It reminded him of the feeding of a boiler by using steam, which occupied a big volume, to force into the same chamber water which occupied a small volume.

He always admired with an almost superstitious veneration the applications of the principles of physics which were made by engineers. Engineers had an instinct or facility for doing these things on a large, permanent, and paying scale, which physicists could only attempt on a ridiculously small scale in the laboratory. The transition was very striking, and the way in which this thing had grown in the lecturer's hands was quite astonishing ; but he felt a little difficulty of a theoretical kind on which he would like the opinion of the Chairman, though he feared that it was so elementary that he might not care to look into it.

The lecturer, instead of using a static method, where the water and the air might stand still if one pleased, or be allowed to go on, if one pleased, used a method which would not work at all unless there were a state of flow. The whole thing depended in all cases on the difference in weight between air and water. Water was 800 times heavier than air. If, therefore, the compression rose to 800 atmospheres, none of these things would work, because the air would then weigh the same as the water. The whole point was that a column of water was being balanced against a column of mixed air and water, and because the air did not weigh anything it could be used to do work. Mr Allen's device was a kind of air-compressing machine ; it was really a kind of water staircase. A very little drop raised the water by so much, another drop raised it further, and so on. It went up step by step, never compressing the air much, but raising the water simultaneously as high as one chose to make the staircase.

The method expounded that evening was different. Here the work was done with bubbles, and he had to say that he was not happy about those bubbles. He spoke with diffidence because of the fact that works on this principle had been installed on a large scale and were efficient. Therefore, he was not complaining or criticising, he was trying to learn. (Sir Oliver Lodge here drew on the blackboard a representation of a U-tube, with water in one part of the tube and bubbles in the other). He said that the lecturer had spoken of the specific gravity of the foam as compared with the specific gravity of the water. He would not deny that the action could be expressed in that way, but it seemed to him that the bubbles must be rising, and that bubbles when they rose dragged up a little of the water with them. Every bubble, going up, dragged the water with it after a fashion, but not very efficiently. If the bubble filled the whole tube the action would be like that of a piston ; here some of the water was replaced by air, and the water and air were balanced even when standing still ; in other words, instead of using bubbles to raise the water, one might use something like pistons to raise the water. In the original static hydrautomat this was what happened, and he would have thought that arrangement to be more efficient than the arrangement demonstrated in the lecture, although it might be a little more com-

plicated. In most hydraulic engineering one avoided making splashes and having foam and white water, one kept to blue water, but here, ingeniously and surprisingly, the foam was used in order that afterwards when it had done its work the water and the air might be separated, the water thrown away, and the air, now unde rcompression, taken to the point at which it was desired to work it ; it then became like the transmission of power, and could be used for any purpose desired, including the pumping of water at a distance.

His contribution to the discussion consisted, therefore, in calling attention to Mr. Allen's old static invention, expressing surprise and admiration at the developments which had been the outcome of that invention, the large scale on which it had been possible to work it, and in asking whether what he had said about the foam and its comparative inefficiency had any value or not.

SIR ATUL CHATTERJEE, K.C.I.E. (High Commissioner for India), explained that he was neither a scientist nor an engineer, but he was intensely interested in the condition of agriculture in his country, and he had listened with rapt attention to what had been described by the lecturer. He was acquainted to a very large extent with the country in the Punjab and in the United Provinces in the North of India, where irrigation canals were of immense benefit to the agricultural people. He was also acquainted with the disadvantages which arose from the souring of the land owing to too much irrigation, and he had been most gratified to learn that these difficulties could be overcome by the appliances and contrivances described in the lecture. It was particularly satisfactory to learn how cheap and effective they were.

MR. FRANK TWYMAN, F.R.S., said that his interest was in the manufacture of optical instruments, and therefore, at first sight, he had little to do with the subject under discussion. But he had been simply enthralled by the account of the work done in this way, and had wondered whether a device of this kind might be of more use in the laboratory in the initial stage of obtaining high vacua, than the water injector which was often used for this purpose.

He added that he thought technical men were often so engrossed in their own affairs as to neglect the ideas which came to them from other technical interests. A manufacturing friend of his had suggested that it would be a good holiday for a manufacturer if he could be set to manage—or mismanage—the works of people in quite a different sphere of industry ; for instance, the optician might for a time manage a brewery ! There was a good deal to be said for such a suggestion, although he did not know that the accountants of the firms concerned would quite approve of such an interchange of technical ability.

MR. M. K. RANGARATHAN (Madras Government Public Works Department), who said that he had come over from France specially to be present at that meeting, expressed the interest which he had felt in reading in engineering journals about hydrautomats. He had had no opportunity of seeing any of them in operation in Northern India, but he had heard from other people who had been to see the installations that they were very satisfactory. He was thinking of making proposals to his local Government at Madras that similar systems should be introduced in Southern India.

MR. T. G. ALLEN said that he was not a hydraulic engineer, and was, therefore, unfamiliar with the science of hydraulics. He did not propose, therefore, to expose his ignorance by discussing this scientific subject before an audience of experts. His only

object in accepting the Chairman's invitation to speak was, in the first place, to congratulate Mr. Boving upon his able lecture, and also to express his admiration for the skill, ingenuity, and inexhaustible patience with which he had evolved these devices. Patience was a virtue which one did not always associate with the average inventor, though it was one which might be reasonably expected to be found in a man whose initials spelt "J.O.B." He was sure it was the wish of all concerned that this modern J.O.B. might in time reap that material reward which was once vouchsafed from heaven to his Biblical namesake!

He desired to say one word with regard to Sir Oliver Lodge's reference to himself. It was true that he once was guilty of perpetrating an invention by which water was made to raise itself without the employment of kinetic energy. It was also true that he christened that invention by the coined name of hydrautomat. But that invention had been superseded by the more practical inventions of Mr. Boving, and only the name survived to commemorate its one-time existence. If he were asked to draw the distinction between Mr. Boving and himself, he might say this, that he (the speaker), was the father of one child which died in its infancy; on the other hand, Mr. Boving had been the father of several healthy children who had now reached a vigorous maturity. He congratulated Mr. Boving upon his procreative faculties, and he hoped this virile father would live long and his progeny increase.

Mr. A. S. E. Ackerman (Secretary, Society of Engineers), rose simply to make one small request, that when this paper was indexed, it should be under "Air Pumps." That would be the natural heading to which people would refer who wanted information on the subject.

Mr. R. W. Western remembered hearing about an invention of this kind some forty years ago, though his memory was not very clear at this distance of time. It was brought out in the early nineties at the McGill University in Canada. The difficulty resided in deciding the size of the bubble. If the bubble was too large it rose quickly and caused turbulence and loss of energy; if the bubble was too small it rose slowly, and there was difficulty in disengaging the gas from the water, involving a separation chamber with increased capital cost. His own recollection was that this consideration weighed very heavily with the Toronto engineer. From what he had learned that day it seemed that these difficulties had been overcome. He supposed that there had been a great deal of work done in deciding the optimum size of the bubble on which success depended.

Mr. W. C. Chopra (Superintending Engineer, Punjab Irrigation), had been nterested to hear about the working of this plant in places with which he was concerned, particularly Bambanwala on the Upper Chenab Canal. As an engineer of that province, and one who had had experience of this contrivance, he would like to ask a practical question. The lecturer had spoken of its high efficiency. But he understood that at Bambanwala the efficiency was as low as 3 per cent. Could the lecturer give any confirmation of that? He also desired to know the limitations of transmission, and the length over which operations could be carried.

Mr. J. S. Marlow, taking up Sir Oliver Lodge's reference to the size of the bubble, said that he took it the efficiency depended on the design of the injector and the injector action of the air in the water. He also wished to know if it was possible to get a constant stream with the air-lift system instead of a spasmodic one.

THE CHAIRMAN expressed his admiration at Mr. Boving's extraordinary versatility in making so large a number of combinations as he had done—air, water; water, air; pressure air, vacuum air; pressure water, water under diminished pressure—all interchanging with one another, making variations of power in any kind of combination required. It was an extraordinary example of the advantage of an exact understanding of the scientific basis of the problem. Mr. Boving was a Swede, and with that practical ingenuity for which Sweden was famous, aided as it was by his own training at the University of Stockholm, he had been able to do these very wonderful things.

In the observations made by Sir Oliver Lodge, he had felt inclined to correct him, or rather to try and remove his dislike of these bubbles which were rising up through the water, and which he seemed to think, were missing their vocation If Sir Oliver Lodge would think further about the matter, he would see that a bubble turned loose in water very quickly came to a steady rate of rising in the water. The moment it had arrived at that stage it induced on the water in which it was rising a lifting force exactly equal to its own buoyancy. That was the case with bubbles of any size; as long as they were lifting themselves freely from water they were having the effect, not of giving a continuous column of water or stationary water, but a column of water in which at every point the air was giving a "push-up," and producing the effect of diminished specific gravity as soon as there was uniform velocity through the water.

SIR OLIVER LODGE said that that was the kind of helpful exposition he would have expected from the Chairman. He thought that Mr. Boys had illuminated the subject. If what he said was true that the effect of this dragging of the bubbles as they went through the water was just equal when it reached the terminal velocity of the rise to the buoyancy of the water, so that the two were at equilibrium—and he thought this must be so—then he had solved the problem. He was very glad that he had asked the question, because it had elicited this explanation from the Chairman.

THE CHAIRMAN, continuing, said that he thought the most surprising and most ingenious of the things which Mr. Boving had elaborated was the method by which he controlled the passage of the river over a weir. It was a most unexpected way of dealing with the problem, but it came down merely to turning on and off a gas tap.

There was one other observation he wanted to make at the risk now of offending Mr. Allen, namely, that the word "hydrautomat" was an admirable word derived from the Greek, and one which explained itself fully when one thought of its derivative terms. But long words derived from Greek or Latin did not trip lightly off an English tongue, and a word was wanted to cover the whole range of Mr. Boving's inventions which would be more English in character, belonging more to the vernacular. For his own part, he would call the whole series "Froth engines." Anybody could remember the term "froth engines," and it had not been used before, so that it would serve to stamp the whole of Mr. Boving's work and identify it.

MR. BOVING, in replying on the discussion, referred first to the effect of the bubbles on the water. If, in a compressor, there were too large bubbles they might even go round in a circle in the water, and thus, although there might be the requisite amount of air to make a balance with the other column, there would not be the requisite compression. It was necessary, therefore, to have smaller bubbles. The bubble tried to escape, and found a form for itself which offered the least resistance

to the water. In doing so it slipped through the water and did too little work—another reason for not having too large bubbles in pumping water.

Mr. Western had asked the size of the bubble. Generally speaking for a compressor the bubbles must not be too small. The ideal would be to have infinitely small bubbles and a large separation chamber, but this was not commercially possible. It had been found that for low head compression, bubbles of the size of half-inch diameter were satisfactory. For high compression one could have larger bubbles at the in-take, because they got squeezed so very small when they came down.

Sir Atul Chatterjee had mentioned the plant at Bambanwala. That plant cost about £900.

Mr. Twyman mentioned high vacua. It was not possible to obtain such high vacua by this method as with the water injector. With the water injector very high vacua indeed could be obtained.

Mr. Marlow had spoken about the injector action on the air in the water. That was a wrong idea. If there was an injector in the water with any great velocity there was a great loss in efficiency too. The conditions for successful operation for the compressor was that the air entered into the water as quietly as possible without disturbance.

Mr. Chopra from the Punjab had made some very pertinent remarks about the Upper Chenab Canal. The first plant was put in two years ago. The efficiency was extremely low in the beginning. In his paper he had mentioned the efficiency for the compressor alone and for the water-lifter alone, and had given an efficiency of 50 to 60 per cent. for the compressors. Those were proved facts. In an air-lifting plant 60 per cent. efficiency had been measured under favourable conditions. When the first plant was put in on the Upper Chenab Canal he was groping in the dark. Certain conditions were laid down by the engineer, and the syphon put in to meet the engineering conditions had an efficiency of probably not more than 15 per cent. The efficiency of the lifter was about 25 to 30 per cent., so that if the two figures were taken together one had a resultant efficiency of something like 3 per cent. However, that plant had been re-built, and the efficiency had been raised to 8 per cent. In a second plant the efficiency was 12½ per cent., and in a third plant 22 per cent.—that is $\frac{d\,f}{DF}$ actual foot lb. in the operating water to foot lb. in the pumped water.

A vote of thanks to the lecturer was carried unanimously.

EXHIBITIONS OF APPLIED ART

British Institute of Industrial Art Exhibition. At the Victoria and Albert Museum. 9th November to 18th December. The present exhibition is divided into three parts. One part is composed of the B.I.I.A. permanent collection; the second, of Mrs. Margaret Bulley's private collection; the third, of newly assembled wares "for the slender purse." The prices of most of these are marked; but they do not always offer much encouragement to the purse that may feel itself fairly described as "slender."

The bulk of modern art and craft productions have a singular correspondence with the more obvious and popular human ideals of the present day, both physical and moral. They have much in common with those clean-cut male physiognomies which figure in advertisements and in illustrations to magazine stories. They are somehow healthy and in a certain sense wholesome; only far more rarely are they

æsthetic. The finish given by machinery is apt to be *superior* and superior is just what works of art are not.

But that the B.I.I.A. is exercising an active and most valuable influence has been clear before this. The average quality of goods displayed is a high one, and if these goods are not cheap, they are not expensive either. Take Messrs. Peter Jones' furniture in weathered oak. The design is not inspired, but—wholesome, and the price is reasonable. Messrs. Wedgwood's table of pottery No. 197, is one of the most impressive assemblages. Here the slender purse rather begins to wilt, for the charming celadon ware set, 197P, turns out to be as inaccessible as it is desirable. The little toast rack itself is five shillings and twopence. But the cream ware, on the other side, is attractive, sensible and cheap ; the slender purse recovers its spirits.

Textiles are, as usual, good. Pots and pans, good. Printing, colour printing, book production, map production, all most competent

And then we come to Mrs. Bulley's collection.

At once we are conscious (or we ought to be), of a more rarified, a more bracing atmosphere. It is true that almost the first thing that strikes one is a carpet design by McKnight Kauffer in this artist's least happy manner But the next moment we are confronted by Duncan Grant's table, dating from Omega Workshop days, but none the less masterly for that. Grant's design for a chair cover, worked by Mary Hogarth, is probably more recent , how rich and how assured it is! Perhaps the most fascinating single object in the whole exhibition is Grant's stove, or more accurately, his tiles for the stove, No. 582 ; the stove itself is admirably designed by Robert Medley. We cannot, alas, expect that modern industry will be so to speak " converted " by a man of however powerful genius, yet it is to be hoped that a sense of Grant's importance will grow increasingly both on our captains of industry and on their men. He has reasserted, with an eloquence all his own, first, the supremacy of good proportions, secondly, the doctrine that the details must be subordinated to the whole

Raoul Dufy's cretonnes, especially those printed in blue on white, are excellent, and so are the textiles shown by Phyllis Barron and Dorothy Larcher. Marion Richardson's " young pupils " are evidently gifted See especially case 569

The Permanent Collection may just now have the opportunity of attracting some of the attention it always deserves. Alan Durst's ivory cross is a design which seems to embody with curious thoroughness certain modern virtues and with them, their defects. Can we still blame the first shock of mechanisation for the readiness with which our craftsmen let discipline pass into a rather unsubtle mannerism ? What a fine artist Eric Gill would be if his manner did not overshadow his matter !

The exhibition is open every day, normally 10 till 5, but on Thursdays and Saturdays 10 till 9 ; Sundays, 2.30 till 6.30. It should give us all our inspirations for Christmas presents. The organisers did not forget to include toys in their catalogue.

NOTES ON BOOKS

PARIS AND LONDON IN 1815. By P. R. Broemel, F.R.S.A. London : Murray and Co. 5s.

Here is a lively and entertaining little book, full of stories about the personalities of the Waterloo period, at home and abroad. It was an age of exquisite snobbery, in which the rich and powerful behaved most barbarously with an air of being unspeakably refined. On the whole it was at least not an age of humbug, and the

great made comparatively little concealment of their more devastating whimsicalities. The Duke of Wellington must be much nicer as a legend than he was to meet.

Mr. Broemel whisks us merrily from the one capital to the other, introducing us to all the rakes, dukes, duellists and demi-mondaines, whispering into our ears all the scandals told about them, and many of the *bons mots* said to have been made by them. We find writers and artists also in his pages ; but was Horace Vernet really a " glorious example " of what the French School could produce ?

That most unsympathetic of heroes, Napoleon, seems to have had one thing in common with his conqueror : a lack of attractiveness for women. His manners were unkind, he was neither a gentleman nor one of " nature's gentlemen." But consideration for others was hardly a characteristic of the *beau monde* that despised and feared him.

The effect of that other Great War on society had been corrupting—naturally. Democratic sympathies were still hardly possible for the people who mattered, and even the way peace was kept for the next forty years does not seem decent to a more liberal posterity. The folk who danced at Almack's and risked their fortunes at the *Salon des Etrangers* were, though they did not know it, celebrating the end of a régime. One hopes there will always be enough money and leisure for those who want to be absurd to have at least a part of their heart's desire, but that these should have been practically identical with the arbiters of the world's destiny was a misfortune, the depth of which Mr. Broemel's little book helps to illuminate.

THE D.I.A. CAUTIONARY GUIDE TO ST. ALBANS. London : The Design and Industries Association. 6*d*.

The general public is to this day far more diffident about criticising architecture than about criticising pictures. The lighter side of building is hardly recognised : people find houses noble, beautiful, squalid, ugly, but not *absurd*. Yet many are nothing more nor less than absurd. Streets are often ruined by individual houses that are not so much Calibans in the wrong place as clowns or mountebanks in the wrong place.

When Mr. and Mrs. Williams-Ellis tried to cure the-man-in-the-street of this particular inhibition by writing a book, they called the book " The Pleasures of Architecture." A very good title, calculated to suggest that it is not always necessary to be solemn about stone and brick. It is Mr. Williams-Ellis who writes the Foreword to the present Guide—and perhaps provides the page-headings and titles to the illustrations.

These photographs are really excellent. " First depressions on arrival," pages 6 and 7, show with what single-minded loyalty to their clients the advertisers of to-day do their work. But man cannot live by petrol and Sunlight Soap alone : see the next two pages. Page 9 makes one feel, not for the first time, that Mr. Woolworth's goods would be just as welcome if he happened to become a convert to æsthetic shop-fronts.

And so on. Page 23 is interesting : it represents a fine new block of offices in red brick, and a printing works which seems to be in concrete, both buildings being dignified and restrained. (Opposite we see a public convenience in the Tudor style, half timber and all !)

One feels that every old town in England ought to have its own Cautionary Guide, and that every inhabitant should have a copy of the one relating to his home.

GENERAL NOTE

THE LEON GASTER MEMORIAL FUND. - Nearly two years have elapsed since the death of Mr. Leon Gaster, Founder, Vice-President and Honorary Secretary of the Illuminating Engineering Society, and there is a strong desire among members of that Society to commemorate in a fitting way the great services which he rendered to the Society and to Illuminating Engineering during nearly twenty years. The Council of the Illuminating Engineering Society has concluded that there is no better way of doing this than by linking Mr. Gaster's name with some scheme which will further the aims which in his lifetime he strove so zealously to foster, namely, to increase the reputation of the Society, to stimulate a high standard in the papers and contributions which are submitted to it, and to encourage experiment, research and investigation.

It has accordingly been decided to institute a "Leon Gaster Memorial Fund." It is proposed that a fund of not less than £200 shall be collected, the interest on which shall be devoted primarily to the establishment of a Premium to be awarded annually for the best contribution from a subscribing member of the Society on any aspect of Illuminating Engineering which is submitted to the Illuminating Engineering Society during the year. It is proposed that the Premium should be used for the purchase of books, instruments or apparatus, as the recipient may desire, and that it should be accompanied by a certificate on vellum recording the award. It is hoped that the requisite fund will be collected and the necessary Trust completed in time for the first award to be made in 1931. Promises of contributions to the Fund ranging from 5s. to £5 5s. have already been received.

The late Mr. Gaster was a member of the Royal Society of Arts for over 30 years and read at meetings of the Society a number of papers and lectures on subjects connected with Illuminating Engineering. It is thought that there may be Fellows of the Royal Society of Arts who may wish to associate themselves with the movement to establish a permanent memorial of his work.

Contributions or promises should be sent to the Honorary Secretary (Mr. J. S. Dow, 32 Victoria Street, London, S.W. 1). Cheques and Postal Orders should be made payable to the Illuminating Engineering Society, and crossed "A/c Leon Gaster Memorial Fund."

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 2. Automobile Engineers, Institution of, at the Merchant Venturers' Technical College, Bristol. 7 p.m. Dr. B. P. Haigh, "The Relative Safety of Mild and High-Tensile Steels under Alternating and Pulsating Stresses."

Electrical Engineers, Institution of, at the University, Edmund Street, Birmingham. 7 p.m. Mr. R. A. Chattock, "The Modern Use of Pulverized Fuel in Power Stations."

Geographical Society, at the Aeolian Hall, New Bond Street, W. 8.30 p.m. Mr. O. M. Tweedy, "The Central African Highway."

University of London, at Bedford College, Regent's Park, N.W. 5.15 p.m. Prof. W. Meyer-Lubke, "Les Origines Historiques des Langues Romanes." (Lecture I).

At King's College, Strand, W.C. 5.30 p.m. Dr. H. C. Barnard, "The Education of Girls in France under the Ancien Régime." (Lecture III.)

At King's College, Strand, W.C. 5.30 p.m. Rev. C. F. Rogers, "Ecclesiastical Music. Lecture III. Some Welsh Hymns."

At the London School of Economics, Houghton Street, W.C. 4.30 p.m. Mr. E. H. Warmington, "The Debt of Medieval Explorers to Ancient Discoverers." (Lecture III).

At the London School of Economics, Houghton Street, W.C. 5 p.m. Prof. P. Vaucher, "L'Ecole Libre des Sciences Politiques."

At University College, Gower Street, W.C. 2 p.m. Miss M. St. C. Byrne, "England in Shakespeare's Day. Lecture VIII. The Theatre in Elizabethan London."

At University College, Gower Street, W.C. 5.30 p.m. Miss E. J. Davis, "How London became the Capital of England." (Lecture III.)

Victoria Institute, at the Central Hall, Westminster, S.W. 4.30 p.m. Sir Ambrose Fleming, "The Garden Tomb at Jerusalem. A Possible Site of the Resurrection."

TUESDAY, DECEMBER 3. Anthropological Institute, 52 Upper Bedford Place, W.C. 8.30 p.m. Mr. A. L. Armstrong, "Report of Excavations in the Cave of Bambata and at the Victoria Falls, South Rhodesia, 1929."

Automobile Engineers, Institution of, at the Royal Society of Arts, Adelphi, W.C. 7.15 p.m. Mr. J. B. Hoblyn, "Aluminium Alloys from the Users' Point of View."

Chadwick Public Lecture, at Inner Temple Hall, E.C. 8.15 p.m. Dr. William A. Robson, Barr.-at-Law, "Public Health Law and Administration."

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Electrical Engineers, Institution of, at the North British Station Hotel, Edinburgh. 7 p.m. Informal Meeting.

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 8.30 p.m. Sir Richard Gregory, "Science and the Empire."

Quekett Microscopical Club, 11 Chandos Street, W. 7.30 p.m. Mr. Montagu A. Phillips, "British Wild Life."

Television Society, at the Engineers' Club, Coventry Street, W. 8 p.m. Mr. E. G. Lewin, "Television: Some Suggested Schemes."

University of London, at Bedford College, Regent's Park, N.W. 5.15 p.m. Prof W. Meyer-Lübke, "Les Origines Historiques des Langues Romanes." (Lecture II).

At King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1861. Lecture VIII —The Time of Troubles."

WEDNESDAY, DECEMBER 4. . Analysts, Society of Public, Burlington House, W. 8 p.m. (1) Lecture by Professor Dr. A. P. Laurie, on "The Methods of Examining Pictures." (2) R. L. Andrew, "The Determination of Minute Amounts of Iodine in Soils and Waters" (3) Dr. S. Glasstone, and Mr. J. C. Speakman, "The Quantitative Analysis of Mixtures of Nickel and Cobalt."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. H. A. P. Hetherington, "Well Boring."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Mr. G. Shearing and Captn. J. W. S. Dorling, "Naval Wireless Telegraphy Communications."

At the Technical College, Derby. 6.45 p.m. Lt.-Col. H. E. O'Brien, "Electric Traction."

Geological Society, Burlington House, W. 5.30 p.m.

Goldsmiths Company's Lecture, Goldsmiths' Hall, Foster Lane, E.C. 7 p.m. Mr. Howard Robertson, "Modern Design and Decoration."

Heating and Ventilating Engineers, Institution of, at Swedenborg Hall, 20 Hart Street, Bloomsbury, W.C. 7 p.m. Mr. R. C. Ching, "Costing Methods for Heating Engineers."

Industrial Psychology, National Institute of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. (1) Dr. A. Macrae, "Interest and Aptitudes" (2) Mrs. Milner, "Temperament" (3) Mrs. Raphael, "Personal Problems."

Literature, Royal Society of, 2 Bloomsbury Square, W.C. 5.15 p.m.

Mechanical Engineers, Institution of, at the Hotel Metropole, Leeds. 6.30 p.m. Dr. H. F. Merritt, "Practical Aspects of Worm-Gearing."

Metals, Institute of, at Thomas' Cafe, High Street, Swansea. 7 p.m. Mr. G. Critt, "Coke Carbonization and Bye-Products."

Microscopical Society, 20 Hanover Square, W. 8 p.m. Meeting of the Biological Section.

North East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-upon-Tyne. 7.15 p.m. Mr. R. Minton, "Pulverized Fuel: Past and Future."

Public Health, Royal Institute of, 37 Russell Square, W.C.1. 4 p.m. Dr. Alfred C. Jordan, "Dress in Relation to Health and Disease."

University of London, at King's College, Strand, W.C. 5.30 p.m. Madame Aino Kallas, "Modern Esthonian Literature. Lecture III – Friedebert Tuglas."

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. A. P. Higgins, "The Development of International Law in relation to Neutral Rights at Sea."

At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture IX on "Office Machinery."

At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "The Reformation Period in Sweden" (Lecture II)

THURSDAY, DECEMBER 5. . Auctioneers' and Estate Agents' Institute, 29 Lincoln's Inn Fields, W.C. 7.30 p.m. Mr. W. S. Edgson, "Some Aspects of Shop Property."

Birth Control and Racial Progress, Society for Constructive, at Essex Hall, Strand, W.C. 8.30 p.m. Debate on Constructive Birth Control, opened by Dr. M. J. Finucane.

Chemical Engineers, Institution of, at Burlington House, W. Conference on "Vapour Absorption and Adsorption." 10.30 a.m. Prof. Dr. J. C. Philip, "The Reversibility of the Adsorption Process and the Thickness of the Adsorption Layer." Dr. W. R. Ormandy, "The Recovery of Acetone Vapours from the Air." 2.30 p.m. Messrs H. Hollings, S. Pexton and R. Chaplin, "The Recovery of Benzol from Coal Gas with special reference to the Use of Activated Carbon." Mr Harry W. Webb, "The Absorption of Nitrous Gases."

Chemical Society, Burlington House, W. 8 p.m. (1) Messrs. U. R. Evans and J. Stockdale, "Passivity of Metals. Part III—The Quantity and Distribution of the Superficial Oxide." (2) Mr. H. Baines, "The Argentothiosulphuric Acids and their Derivatives. Part I—The Preparation of the Sodium Salts and the Isolation of Monoargentomonothiosulphuric Acid." (3) Messrs. W. N. Haworth and C. R. Porter, "Sugar Carbonates. Part IV—The Dicarbonates of Glucose, Fructose, Mannose, Galactose and Arabinose." (4) Messrs. W. N. Haworth and C. R. Porter, "Isolation of Crystalline α- and β-Ethylglucofuranosides (γ-Ethylglucosides) and other Crystalline Derivatives of Glucofuranose."

Electrical Association for Women, 46 Kensington Court, W. 7 p.m. Mr. H. Bourne, "Practical Hints about Bells, Batteries and Wireless Sets."

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Dr. H. Norinder, "Surges and Over-Voltage Phenomena on Transmission Lines due to Lightning and Switching Disturbances."

Linnean Society, Burlington House, W. 5 p.m.

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. Percy Lovell, "Sir Christopher Wren and his Influence on the Craftsmen of his Time."

Mechanical Engineers, Institution of, at the Royal Technical College, Glasgow. 7.30 p.m. Mr. John McNeil, "Nickel Non-Ferrous Alloys with special reference to Steam Engineering."

At the Engineers' Club, Manchester. 7.15 p.m. Mr. Thomas Hart, "The Conversion of an Electric Hoist."

Philological Society, at University College, Gower Street, W.C. 5.30 p.m. Prof. Dr. Sir Israel Gollancz, "Problems in the Alliterative Poems."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Eccles, "Montaigne" (in French). (Lecture IX)

At Bedford College, Regent's Park, N.W. 5.15 p.m. Prof. W. Meyer-Lübke, "Les Origines Historiques des Langues Romanes." (Lecture III)

At King's College, Strand, W.C. 5 p.m. Dr. W. Robson, "Protein Metabolism." (Lecture IV)

At the Royal Society of Medicine, 1 Wimpole Street, W., 5 p.m. Dr. H. P. Mosher, "The Lower End of the Esophagus at Birth and in the Adult."

At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Linea del Paradiso." (Lecture V)

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Momentous Lawsuits and Trials in various Countries from Classical to Modern Times." (Lecture IV).

At University College, Gower Street, W.C. 5.30 p.m. Prof. E. G. Gardner, "Shelley and Italy."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Mr. E. Gill, "Lettering."

FRIDAY, DECEMBER 6. . Chemical Engineers, Institution of, at Burlington House, W. Conference on "Vapour Absorption and Adsorption." 10.30 a.m. Mr. A. Hoch, "The Recovery of Volatile Solvents (Bregeat Process)." Mr. J. Stanley Morgan, "The Continuous Adsorption of Gases by Adsorbents." 2.30 p.m. Mr. G. W. Himus, "Evaporation of Water in Open Pans." Messrs. K. Evans and H. F. Pearson, "The Industrial Application of Active Carbon."

Electrical Engineers, Institution of, Savoy Place, W.C. 7 p.m. Dr. C. V. Drysdale, "Alternating-Current Potentiometers and their Applications."

Geologists' Association, at University College, Gower Street, W.C. 7.30 p.m. Lecture on "The Great Barrier Reefs and the Queensland Coast: A Geographical Reconnaissance."

Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Mr. A. B. Gowring, "The Demolition of Lambeth Bridge."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Discussion on "Diesel Engine Developments" introduced by Mr. W. A. Tookey.

North East Coast Institution of Engineers and Shipbuilders, at the Mining Institute, Newcastle-upon-Tyne. 6 p.m. Prof. Dempster Smith, "Cutting Capabilities of Lathe Tools."

Royal Institution, 21 Albemarle Street, W. 9 p.m. Mr. Hugh Walpole, "The Novel and the Creative Spirit."

Rubber Technologists, Institute of, at the Manchester Café Ltd, Exchange Building, Manchester. Mr. H. Young, "Works Control in the Rubber Industry."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture VIII—The Modernist Theatre."

King's College, at 40 Torrington Square, W.C. 5.30 p.m. Dr. O. Odložilík, "Outlines of Czechoslovak History. Lecture III—The Beginnings of Reformation in Bohemia."

At University College, Gower Street, W.C. 5.30 p.m. Dr. Jal Dastur C. Pavry, "The Religion of the Parsis." (Lecture I).

SATURDAY, DECEMBER 7. . L.C.C. The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Mr. Montagu A. Phillips, "British Wild Life off the Beaten Tracks."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

No. 4020 *FRIDAY, DECEMBER 6th, 1929* VOL. LXXVIII

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

NOTICES

NEXT WEEK

WEDNESDAY, DECEMBER 11th, at 8 p.m. (Ordinary Meeting). MAJOR CHARLES WHEELER, O.B.E., M.I.A.E., late Chief Automobile Engineer, General Post Office, "Overheads and other Factors influencing Road Transport Costs from an Engineer's View-Point." MR. JOHN MAUGHFLING, C.A., will preside.

FOURTH ORDINARY MEETING

WEDNESDAY, NOVEMBER 27th, 1929. DR. FRANK S. SINNATT, F.I.C., M.I.Min.E., in the Chair. A lecture under the Dr. Mann Trust on "The Examination of Coal and Coke by X-Rays," was delivered by MR. C. NORMAN KEMP, B.Sc., A.I.C., Secretary, Royal Scottish Society of Arts. The lecture will be published in the *Journal* on December 13th.

DR. MANN JUVENILE LECTURES

Under the Dr. Mann Trust, CAPTAIN C. W. R. KNIGHT, M.C., F.R.P.S., F.Z.S., will give two lectures for children on "The Golden Eagle," and "Wild Life in the Treetops," at 3 o'clock on Monday afternoon, December 30th, and at 3 o'clock on Wednesday afternoon, January 1st. The lectures will be illustrated by cinematograph films. The syllabus of the two lectures is as follows:—

> LECTURE I (December 30th).—THE GOLDEN EAGLE. Romance of the Highland king of Birds—three eyries. The Adventures of William and his sister. The Crowning Climax. Slow motion film of Golden Eagle's flight. The liberation of Captain Knight's trained Eagle in Sutherlandshire.

LECTURE II (January 1st).—WILD LIFE IN THE TREETOPS. Close hand observations (pictures) of some of Britain's most dramatic birds in their tree-top homes—Herons, Hawks, Owls, Woodpeckers—as shewn in intimate studies. The pictures taken from an observation post on the swaying treetops are of exceptional beauty and thrilling interest.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

CANTOR LECTURES

MONDAY, DECEMBER 2nd, 1929. SIR RICHARD A. S. PAGET, Bt., in the Chair. DR. E. G. RICHARDSON, B.A., Ph.D., D.Sc., delivered the last of his course of three lectures entitled "Wind Instruments from Musical and Scientific Aspects." On the motion of the Chairman, a vote of thanks was accorded to the lecturer for his instructive and interesting course. The lectures will be published in the *Journal* during the Christmas recess.

PROCEEDINGS OF THE SOCIETY

THIRD ORDINARY MEETING

WEDNESDAY, NOVEMBER 20TH, 1929

MR. ROGER E. FRY, in the Chair

THE CHAIRMAN said he felt very much honoured in being allowed to preside at a lecture by Mr. Morley Horder on the preservation of rural and urban England, because, although he was not an architect, he had always had a great interest in architecture, and had sometimes rashly intervened in discussions of that subject, an indiscretion which he hoped to repeat that evening at a later stage. There was no doubt that rural and urban England was disappearing as fast as ever it could, certainly the rural and urban England which had been admired and liked ; and the question was, What was going to replace it, or to what extent could it be preserved ? It would not be preserved by the natural force of circumstances, only by a very definite desire on the part of those interested in it ; and, of course, it was a very delicate question whether it was any use preserving a thing which would naturally go

In approaching this question, it had to be considered what was really wanted There were three types of people who had different desires, whom he would classify as the poets, the commercialists and the artists. Among the poets he would include the mass of the public, the cultured people, a good many journalists and the professional poets. These three classes of people all wanted slightly different things

The poets wanted the country to be kept entirely free of people; they wanted the people to be in towns, because the tradition of the English poets was that they got their inspiration from being alone in the country; and Wordsworth had objected very much to anything that would bring people to the Lake District. In a vague way, the general mass of the public had the poetic outlook. The commercial man had a definite outlook, which need not be discussed. The artist was in a peculiar position, because he was not as exigent as the poet. Whatever was done, he knew he would find his own business in it. Speaking as an artist, he thought perhaps the artist's one desire was that the journalist should not have his way. The artist objected to the country being altered in the direction of what the cultured journalist called "artistic development." The artist, he thought, had no desire to keep pylons away from the Downs, or railways away from the mountains; on the whole, he rather liked to see them there. That was where he differed from the poet. Those seemed to him to be the three classes who had to be considered in the matter; and he hoped Mr. Morley Horder would explain all that, and a great many more things.

The following paper was then read:—

URBAN AND RURAL AMENITIES

By P. Morley Horder, F.S.A.

Some eight years ago, in a provocative address to the Royal Institute of British Architects, your Chairman to-night said "the vices of modern English architecture have always been inherent in the architecture of England." Modern conditions have brought out the rash! Modern conditions and modern science have put in the hands of modern architects the greatest opportunity in the history of the world. They have missed it completely, but to a great extent it was not their fault.

The unsettled condition of Europe and life generally since the War have only increased the rash, and there has been very little attempt to standardise the form of building into proportions suitable to the new conditions of living. We seem incapable of creating forms of building expressing new forms of construction, or preserving our traditional buildings with any courage for the value they obviously possess. The seemly and orderly late 18th century street architecture of Regent Street is now a series of architects' *motifs* with very little relationship to each other, and a noble street has been replaced at an enormous cost by an inferior one for the lack of a controlling idea. The complicated system of tenure and the necessities of revenue occasioned by the War account for the haphazard way London is being rebuilt, and it is difficult to suggest how any control can be exercised by the Architect, when it is possible to destroy the whole scale of a great thoroughfare like Park Lane without any certainty that the new scale established by the mammoth hotel will be respected both as to the height and materials of the new buildings which must certainly take the place of the old houses with which this generation is so familiar. The public are shocked at the sudden appearance of a building of these dimensions, and they hardly realise that they are fortunate (given the necessity) in the manner of the architecture of the new building in this street. This new block is so dominating

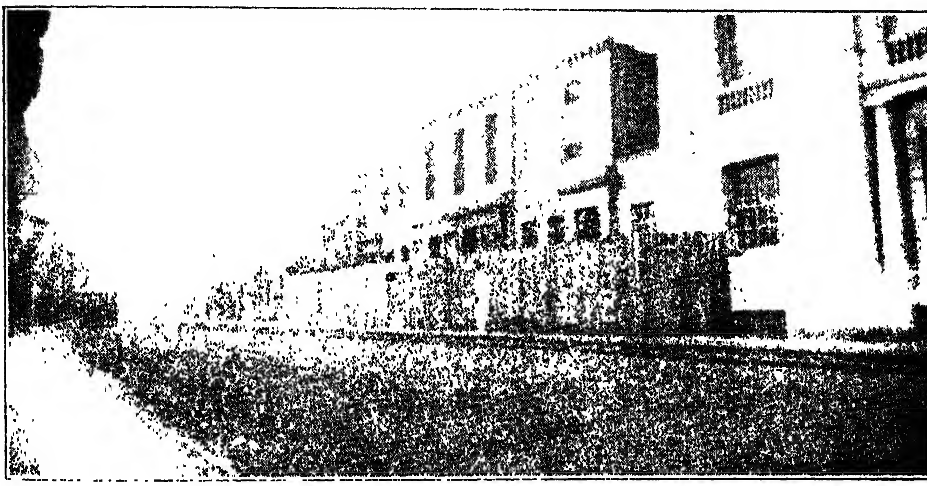
in its scale there surely can be no excuse for not following its lines and materials in any new buildings which must inevitably rise along the whole length of the Park.

The London Parks are its greatest possession, and in Regent's Park we have a beautiful contrast of woodland emphasized by the ordered terraced houses, as characteristic of London as anything we possess. Huge blocks of flats are interrupting the once ordered serenity of the district. Regent's Park is Crown property and it may be necessary to rebuild and destroy the work of Nash and Decimus Burton. If so, here is an opportunity to control the grouping and materials of the new order of building with some standardised forms worthy of the surroundings. If the Londoner is forced by circumstances to live in flats, no finer situation could

Newcastle House, Lewes. October, 1929.

be found ; but it needs foresight and vision if so beautiful a district is not to be at the mercy of the estate agent and the contracting mind. Portland Place was until recently one of the noblest of our London streets ; it is now becoming typical of the hopelessness of our manner of dealing with architectural problems. For years its ordered fronts have been undergoing alteration, and now its continuity of design is to be frankly interrupted by new buildings, and its sky-line still more broken. The new British Broadcasting building which is being built here will no doubt be a very fine modern building, but it surely will be altogether out of scale with the street. I understand that the Royal Institute of British Architects are to build their

new home in this street. It is rather sad to think that they will further displace the street design of a great architect. The expression in architecture of the manner of another age must of necessity give place to the requirements of a new era, but one wishes it could be done in a less piecemeal way and with greater vision. The splendid scale of this street with its noble vistas to the Park was a great possession, and its reconstruction could obviously not be a success unless all the façades of the buildings therein were controlled by one mind. Apparently this is too late, and Portland Place will repeat all the errors of Regent Street, although it may contain many individually fine buildings. It is regrettable that the British Broadcasting Company and the Royal Institute of British Architects did not try to find a site, and associate themselves with the new Charing Cross Bridge, in connection with which surely sites of great architectural importance will be opened up. The Institute is at present housed in a building of considerable character. The new



Newcastle House, November, 1929

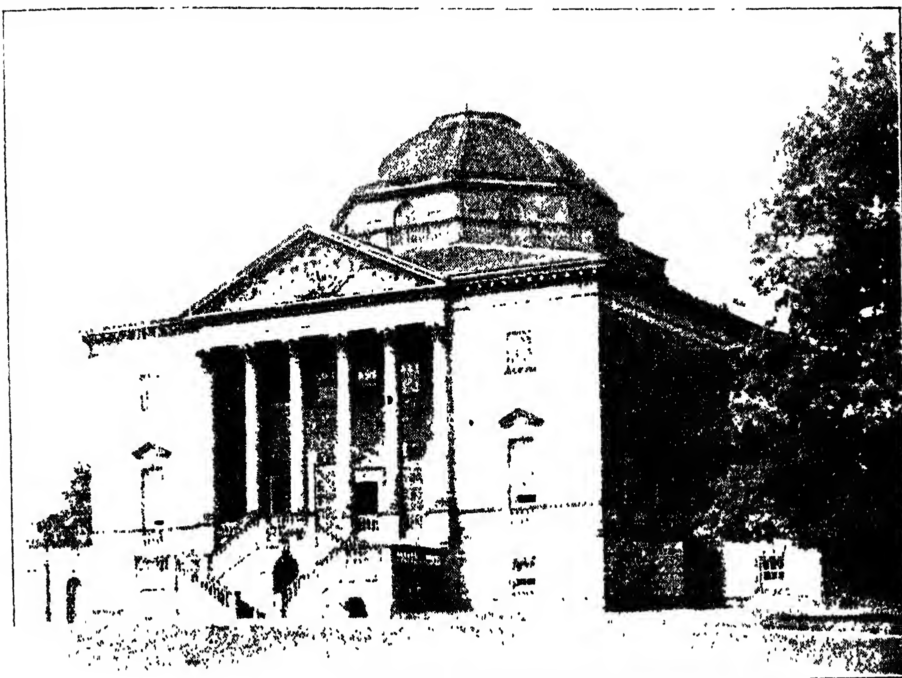
Bridge and the replanning in connection therewith should be the greatest opportunity for the engineer and the architect which has occurred for a generation. How suitable it would have been if the Architects could have housed themselves in a great modern building here associated with the modern development of wireless, instead of confusing the ordered architecture of another century. The cumulative effect of the street architecture of Adam will be lost to London, to the advantage, no doubt, of the owners of the ground rents. Thus is the art of architecture the sport of individuals. How far the growth of London will tempt the ground landlords as their leases fall in, to rebuild their streets and squares with any consistency, seems uncertain. If Lansdowne House is doomed, no doubt Berkeley Square will be rebuilt and become a shopping centre in the same way as Portman Square. The rebuilding of Portman Square was a real opportunity for a modern

Adam or Nash to have been employed to design a noble square on modern lines with some real architectural articulation of the four sides. Such a scheme would have dealt successfully with the motor car, as part of the necessities of such a development, even if the gardens had to be sacrificed. The failure here to realise a complete architectural scheme should encourage the advisers to other estates in London to have some definite scheme of development for their squares and streets, and endeavour to arrange their leases to make it possible to rebuild on some definite architectural lines. Impressive squares and streets are impossible unless the units composing these are architecturally conceived by one mind. The best illustration, I suppose, of such conditions is the town of Bath, for which the architect, Wood, of Bath, was so largely responsible. The Royal Society of Arts building is a fitting place in which to speak of such a satisfying unity of ideas, as the streets of the Adelphi really illustrate all one has to say on the subject of the restfulness of proportionate detail interpreted in one material.

The standard of architectural knowledge and training is probably higher than it has ever been, and it is deplorable that there is so little evidence of this in the general rebuilding of our towns and villages. The very fact that one is astonished at individual beauty and simplicity in isolated buildings here and there, is an indication of how little the educated mind counts in the general rebuilding of our towns and villages. The excellence of the design of - say - a small bank or post office, or a village inn, only seems to emphasize the general vulgarity of the new buildings which spring up as isolated units on the great new roads, or in huddled masses on the coast, or as outcrops from our beautiful old towns. The daily press is full of protests on the subject of the disfigurement of England, and there are over fifty societies whose object it is to preserve the countryside or some relative part of its beauty. Innumerable books are published illustrating the beauty of England and its traditional building. The protests would appear to be sufficiently provocative, and the books eloquent. But they all reach a very small circle of interested and educated people. Is the man who lives in the hideous bungalow that offends us really always responsible for it. Many of these people either cannot get houses in the towns, or have a yearning to get away from their crowded or slummy surroundings at any price. The sense of possession of the smallest piece of land appeals to them, and they are intrigued by advertisements, and have often to put up with the merest shack of a house. Hardly any of these people are responsible for the character of their houses, many of which will be beyond repair before their last payment is made - if it ever is ! The owners of great estates have no doubt been forced by circumstances to sell their land, but the haste that has been recommended by interested agents is the cause of the ill-considered development. Even if they desired to exercise control in the development, they have been told that any restriction would prevent a ready sale. This short-sighted policy has meant the depreciation of the land all round such unpleasant development. We are all familiar with the prospectuses of the development of a new estate, and the glowing terms in which its rural features are set forth, and all the safeguards for preserving

its amenities. The accompanying plan generally exposes the fallacy of all such attempts. The surveyor-mind regards the area as so much space for the exercise of his ingenuity to get as many slices of land on to a given road, irrespective, usually, of the contours, natural boundaries, trees, aspect or views. The dreary roads are made, and sewered, and the controlling principle of the houses that eventually jostle each other with their conflicting designs and materials, is that they are supposed to have cost not less than so-much.

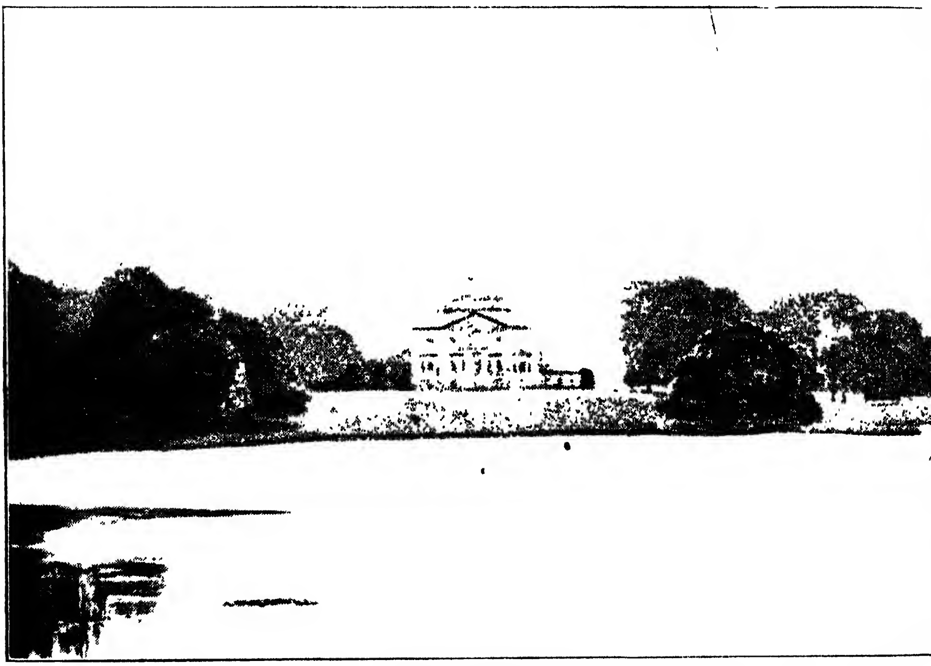
What is the remedy for all this ignorant destruction of this wonderful country and our interesting towns? Have we any confidence that regulations and schemes of town planning are likely to improve the conditions? There are more societies



Nuthall Temple, Nottingham.

than ever before for protecting everything, from a Cathedral to a wildflower! But the growth of unpleasant buildings and the general conditions of untidiness and destruction of natural beauty increase almost in proportion as the regulations for building become more onerous and exacting. We get very excited about projects for carrying, on suitable standards, the necessary electric current to assist the dying industry of agriculture, but the needless destruction of beauty which goes on day by day is soon forgotten. The public cannot be asked to buy all the estates, whose development may endanger the beauty of England; why must there be so much fear of brick and mortar? Mr. Flower, whose services to Stratford-on-Avon

are so considerable, has made himself responsible for the preservation of the Welcombe Estate near Stratford. Why not develop it under wise direction? Try a sample house and see if with the right materials and with real consideration of the individual placing of each house, the fear of building is not groundless. The experiment of the larger view of Estate development is being tried by Lord Iveagh, near London. Surely it is a slight on modern architects if they cannot satisfy the educated layman that modern architecture can be as beautiful as in the days of Shakespeare. Let the houses be frankly modern and adapted to the requirements of to-day, with no attempts to use methods of building that have no meaning



Nuthall Temple.

for this age. There is a well-known Estate near London still unspoiled, full of natural beauty. The owner has bought another property in a distant County. All appeals to his sense of inherited beauty have failed, and his Architects are instructed to parcel out the Estate to its utmost capacity of return. The immediate return in ground rents will, no doubt, be considerable, but surely it is possible that the secured amenity value might yield a more permanent return. The purchaser would gladly pay more for security of beauty. It is this selfish ownership of land that accounts for a great deal of the boring hideousness of modern development. The Advisers to the great Estates are not always disinterested, and future slums will be the consequence. The Architect himself does not touch these larger problems. He merely deals with individual buildings. Is it not time he was

called in to direct personally the undertakings of our impoverished landlords, not at so much a building, but for a fee commensurate with his vision? The ominous word "Pylons" associated with this necessary communication of electrical supply, looms large in our imagination. The design for these so-called "Pylons" has been approved by an architectural authority—why could not one of these be put up for inspection? It is quite likely that they would hardly be noticed in relation to the sweeping landscape of the downs—they certainly will be harmless compared with the ugly and congested "Bungaloid" groups which are springing up everywhere. We have got accustomed to the necessary telegraph poles which line and almost seem to give direction to many of our roads sweeping over open country; their tidy usefulness does not offend. I even know an aerial station and aeroplane hangar which seem quite beautiful compared to the houses which surround them. All of this goes to prove that what is essentially necessary and is carried out with an economy of means is never offensive.

The Royal Society of Arts is essentially an institution for educating the public mind in the Arts and Sciences, and there is no society with so complete an equipment to influence taste in every direction and to emphasise the importance of preserving all that matters in our traditional building and to point the lesson which these buildings illustrate. I can best illuminate these desultory remarks about town and country buildings by some typical examples of the work the Society has been doing.

Mr. Morley Horder then showed a series of slides of West Wycombe Village, which the Royal Society of Arts is actively engaged in re-modelling; the unique cottage at Smarden, Kent, which through the vigilance of the Society is now in safe hands, without the Society having been put to any expense: and the interesting group of cottages known as the Thomas à Becket Cottages at West Tarring, Sussex.

A photograph was shown of Newcastle House, Lewes, which has been the subject of public controversy for some time, and it was generally thought had been saved. Mr. Morley Horder stated that he had a telephone message from Mr. Godfrey, the well known architect and antiquarian, who lives in Lewes, informing him that it was in the course of demolition, and Mr. Godfrey sent some slides showing this. The Royal Institute of British Architects were appealed to to save this building, but they intimated that they were not concerned with buildings of beauty which were picturesque rather than architectural. Considerable interest was taken in these slides, and it was resolved to send a telegram to the Town Clerk of Lewes, deploring its destruction. The Lecturer pointed out that this building could hardly be described as characteristically picturesque, and it would be surprising if anything could be put in its place which would be as satisfying in its relation to the other irregular lines of the street. Apart from any question of architecture, was it not sheer waste to pull down such a building, which obviously could be adapted to the reasonable requirements of the Local Authority of a small country town? The local protest in connection with this proposed destruction seemed so general and authoritative that one despaired of any effort to save interesting buildings if the ratepayers in a town like Lewes had no more interest or authority than to allow such an outrage. It would be interesting to see the type of building which took the place of the pleasant but unassuming house.

Photographs of Nuthall Temple were then shown. Mr. Morley Horder said that this was one of the finest examples of Palladian architecture we possessed in England and pointed out that if the architectural profession regarded Newcastle House as merely picturesque and therefore outside the province of an architectural society, what could be said of the destruction of so noble a building ? Apart from the architectural values of the buildings, the view from the colonnade was one of the most characteristic English vistas. Surely this was a possession of the greatest value to Nottingham, especially as it was within a short tram ride from the centre of the town. It is believed that the building was sold for about £4,000 to a builder, and was by now probably entirely demolished. Up till the actual day of the sale, everything possible was done to arouse public attention, both in Nottingham and London, in the matter. Then, when it was too late, the local paper said ; " The destruction

William Shenstone's House The Leasowes, Halesowen

of Nuthall Temple is perhaps the worst piece of vandalism for which—someday—our present generation will be held responsible." A well-known and rich citizen of Nottingham said he had never seen the place and had never met anybody who had ! Such are the depths to which an appreciation of fine architecture has fallen.

The Lecturer also mentioned that the Royal Society of Arts had been appealed to by the Secretary of the Shenstone Society to help in the preservation of Shenstone's interesting house and surroundings, and that he had taken the opportunity, when near Birmingham, to go and look at the house and gardens, the description of which he was familiar with. Very little remained of the garden as described, but the seemly and orderly house of the period (now used as a golf club) remained much as it was in Shenstone's time, and the surroundings, which were threatened by the speculative

builder, were still attractive. In his introduction to "Men and Manners," Mr. Havelock Ellis said: "Shenstone is ranked among the minor figures in literature, even in eighteenth century English literature. Yet he has always been a significant figure for those who are able to see what signifies, and to-day his significance, not only for England but for Europe generally, continues to increase." In the "Cambridge History of English Literature," where we might reasonably expect to find the standard literary opinion of our time, it was noteworthy that both Mr. Saintsbury, who dealt with the minor poets of the eighteenth century, and Canon Hutton, who dealt with the minor prose writers, alike independently referred to the undue neglect of Shenstone; "a tendency at all times to treat him too lightly," said the former, who added, also taking his prose into consideration, that we may put Shenstone after Collins and Gray for "The root of the matter": while the latter stated that Shenstone's prose had too long been neglected by lovers of good writing. As regards Shenstone's wider significance in the development of ideas in the modern world, that has been minutely studied of recent years by various writers in Germany and Switzerland and America."

He would like to remind the architectural profession in Birmingham that although Shenstone ranked as a poet in a rather superficial age, it was really suggested that he should be remembered for better reasons. Disraeli said:- "When we consider that Shenstone, in developing his fine pastoral ideas in the Leasowes, educated the nation into that taste for landscape gardening which has become the model of all Europe, this itself constitutes a claim on the gratitude of posterity. Thus the private pleasures of a man of genius may become at length those of a whole people." Shenstone died in 1763. The Society of Arts was founded in 1754 as an encouragement to the Arts, and it would be very suitable if the Society could arouse Birmingham to a sense of their responsibility in connection with this interesting literary association in their neighbourhood. "Your town of Birmingham grows very polite," wrote Lady Luxborough to Shenstone, "I think the Players who enjoyed the pleasure of your grove should have entertained you there. How delightful would be the Masque of Comus acted on this spot."

DISCUSSION

The Chairman said everyone must have been appalled by the destruction of such objects as the Nuthall Temple, a building which might easily have been adapted to all sorts of modern uses. At the same time, it was difficult to know what could be done. The best chance seemed to be that each county should undertake the work for itself. On the other hand, important as it was to preserve architecture, it was infinitely more important to educate the public in the desire for new and for beautiful architecture. He thought the last few years had shown a growing interest in the mass of the ordinarily educated public in architecture. If the hopes for the future of architecture in Europe were to come to anything in England, a number of old habits and old abuses would have to be swept away, a number of privileged positions would have to be destroyed, and the innate conservatism of the English in preventing those necessary changes would have to be overcome. Coming back from Italy, where architecture was endemic, he had wondered what was at the bottom of the difficulty of good building in England, and one thing seemed to be the inferiority complex of the English. The English were afraid of any big or generous gesture in public. Even the vile things erected in modern Italy had at least got self-confidence and generosity; whereas the idea in England seemed to be that a building must necessarily be very bad, and so the least possible should be done. He would rather see wild, desperate,

costly experiments made with public buildings than the niggardly, hopeless attitude with which the English muddled through their national monuments and public buildings.

SIR RICHARD PAGET, Bt., Hon.A.R.I.B.A., agreed with the Chairman that it was even more important to produce good examples of architecture in the present than to preserve good examples of former work. He did not think that the lack of enterprise of the English was entirely due to an inferiority complex; it was also due to the national laziness. It was impossible to have new architecture, using new materials and solving new problems, without a lot of original thought; and most people were extremely disinclined for original thought. Scissors and paste were much easier to handle than brick and stone, and therefore it was left to the engineers, like his friend Dr Faber, to deal with the structure, which was then covered in whatever style was wanted. That, of course, was fundamentally bad and wrong, and the present generation would be blamed and despised in the future for its want of courage in dealing with its present problems. Each generation ought to leave behind it examples showing the continuity of its architectural development. It was terrible to pull down a building like the Nuthall Temple; but it was equally terrible to build a street like Regent Street when there was a really great opening for really great building. Regent Street was one continuous shop from start to finish, with tube stations at each end. It might have been the most convenient centre in the world; but instead of being treated as one, it had been treated as a number of separate shops, so that one could not get from any of the tubes or buses into the shops without going into the rain. That was a disaster which a little forethought might have prevented. It should be demanded of architects and designers that they should provide buildings which really satisfied modern needs. We must solve our own problems in a rational, serious, scientific, engineering, sympathetic and artistic manner.

DR. MARY BOOTH expressed the opinion, as one who had been out of England for fifteen years, that the matter under discussion was a British Commonwealth matter. In the Dominions children were brought up with great love and reverence for the beauty of England, and it was a tremendous disappointment to come back and find that many old beautiful buildings had vanished, with only a small tablet on an adjacent wall to say what had been there, and sometimes not even that. Seeing that there was a large number of societies all intent on preserving beautiful buildings, she wondered why something more could not be done. It might be advisable for them to employ a publicity agent.

A MEMBER OF THE AUDIENCE remarked that probably a good deal of the trouble about the preservation of beautiful buildings was due to the ratepayers not voting for the right people on their local councils.

SIR HENRY MIERS, F.R.S., said he had been shown an excellent scheme in one of the Scandinavian countries, where a large piece of land was reserved where examples of various periods of architecture were preserved.

In England there were a great many things which the English people did not seem to think it was worth while to make beautiful, such as office buildings, and even gas-holders. Even gas-holders could be made presentable.

DR. OSCAR FABER called attention to the outstanding case of Durham Castle, which had been found to be failing some two years ago, and for the preservation of which only one-fifth of the requisite money had been subscribed. Durham Castle was

probably a unique specimen of Norman domestic architecture. He imagined that in relation to Durham Cathedral it formed a group of buildings on the brow of a hill which was unique in the whole world. There was a serious risk of Durham Castle slipping bodily off the brow of the hill and being discovered one morning in the river unless the restoration were completed.

He thought it was possible to go too far in the attempt to preserve the old. In the case of exceptional examples, a very substantial effort should be made to preserve them; but if the nation was to continue as a really virile nation, it must continually replace the old with new. It must scrap dead things and go for the live thing. One could not make new aeroplanes out of old carts. He was satisfied that if the present generation did not build as well as earlier generations, it was due not to any lack of technique. It was much more a spiritual question than a question of technique.

A Member of the Audience asked whether the pylons on the Downs were to be taken as possessing aesthetic beauty. Speaking as a Philistine, he had learnt from the Chairman to understand and to accept things in an artistic sense which were prima facie repellent to him.

The Chairman said the reply to the last question depended upon whether one took the poet's or the artist's standpoint. The poets wanted to look at things entirely from their associated ideas The associations of any recent piece of engineering work were vulgar; the associations of old pieces might be quite different. The windmill was a piece of engineering, and it had become, in course of time, an object of beautiful and poetic associations. Similarly, railways were ceasing to have the vulgar feeling associated with them; they were becoming almost romantic. When he spoke of the beauty of useful and necessary engineering works, he was speaking from an artistic point of view, in which associated ideas were of no consequence, and in which a succession of pylons running along the Downs might add to his sense of the beauty of movement of the surface of the Downs. From his point of view, what had destroyed rural England was the planting of the hedges in the fifteenth century, which destroyed all sense of the sculpture of the earth A railway running round the curve of a hillside might give more significance to that curve. There would always be two fundamental points of view on that subject

Mr. G. K. Menzies said he wished to pay a public tribute to the lecturer for the great amount of time, energy and professional skill which he had devoted to the Society's work in connection with the preservation of the villages of West Wycombe, Arlington Row, Bibury, and other places. Nobody but himself (Mr. Menzies), knew how great a debt was owed to Mr. Morley Horder for that work. He pointed out the urgent need of the Society for further funds in order to carry out that work satisfactorily and with expedition.

Mr. E. Hockliffe said the Chairman was well acquainted with the work done by the National Art Collections Fund, and asked whether it would not be possible to make an appeal to form a similar fund for the preservation for the nation of works done in the past by Englishmen.

Sir Richard Paget pointed out that the Council for the Preservation of Rural England co-ordinated the work of all other similar societies.

The Chairman said there was already a National Arts Collection Fund, which only required further financial support to do more work. The advantage of a society

which collected pictures was that it could show them in some central place like London. Probably if it had been possible to save the Foundling Hospital, and turn it into a public building, accessible to everyone for some public purpose, that would have been an object-lesson of the kind that the National Art Collections Fund had really been successful in bringing about.

THE LECTURER, in reply to the discussion, said he had nothing further to add except that he was very much obliged to the audience for listening to his desultory remarks about rural England, and to Mr. Roger Fry for his kindness in taking the Chair.

On the motion of the Chairman, a vote of thanks to, the lecturer was passed unanimously, and the meeting then terminated.

NOTES ON BOOKS

A CATALOGUE OF PAINTINGS IN THE COLLECTION OF JULES S. BACHE. Privately printed.

This book of reproductions is sumptuous but sober, and worthy of a fine collection. Of the three Giovanni Bellinis in Mr. Bache's possession one might most covet the Madonna and Child, which has the suave strength of the master's best work. Unaffected and graceful, it is designed with science and executed with loving artistry ; one could not weary of it. Though hardly to the point, it is interesting to note that the picture was once in the collection of William Beckford.

The Crivelli Madonna and Child is as characteristic as nearly all Crivelli, with its watered silk and symbolic fruits, frieze carved in stone and odd naturalistic bluebottle. Who can wonder that the " exile of Ascoli," as some journalist before his time might have described Crivelli, only managed to build up about three pictures per annum ? The Madonna's lips are rather small, her fingers rather attenuated, but the attractions of the picture communicate themselves to her.

The lady by Domenico Veneziano, perhaps Elisabeth of Montefeltro, has a coiffure of the kind, common in her day, with which Baldovinetti's lady has most familiarised visitors to the National Gallery. Speaking of Montefeltro : it is to be observed that the Giuliano de' Medici to whose portrait by Raphael we come later on was one of that exquisite and immortal group assembled at Urbino in 1507, at the court of the great Federigo da Montefeltro's son and successor. Giuliano was the friend as well as model of Castiglione, and he appears in Sir Thomas Hoby's translation of " The Courtier " as My Lord Magnifico.

Mr. Bache's Filippino Lippi has that tender, wistful charm which the son of Filippo and pupil of Botticelli expressed so delicately in a manner all his own. Of sterner stuff are the three Titians in this remarkable collection. The Venetian Nobleman's cloak, chain and sword-belt lend themselves to a strong design. The Venus and Adonis is similar in composition to our own and several others ; here the cherub is not asleep under a tree, but a spectator of the passionate scene.

These are only a selection from the impressive list of Italian pictures, which comes to an end with a Cosimo Tura, and is followed by a choice series of Flemish pictures.

Bouts could paint with grace, but not with the grace of Van der Weyden ; he is most personal when he paints with verve and " lets himself go " ; so we linger with less attention over his Madonna than over the Carthusian of Petrus Christus or David's Nativity. The sturdiness of David, his grave, unsensational design and

patient craftwork, are guessed here more easily than from his Madonna, which follows. Memling's Madonna has the *finesse* that we know we can be sure of finding, but here as elsewhere the draughtsman has a little thwarted the painter, and we get a somewhat flat, unsubstantial Child in the more solid Madonna's arms. The Van der Weyden Man with Turban is interesting, but does not reveal the master's power.

Van Dyke, painted by himself, is shown as a *beau garcon*, worthy of his august patrons. The roving eyes and sensual lips are not here robbed of any of their magnetism by moustache and beard, as in the Louvre portrait. The Earl of Warwick may well have been pleased with the ultra-dramatic representation of himself made by this most talented of virtuosi.

Mr. Bache's Dutch pictures include three Rembrandts, two of which he was good enough to lend to the Burlington House exhibition this year. In Curiosity, Terborch has indulged his fancy for white satin, and arranged his little comedy in a better judged volume of pictorial space than he sometimes gives us. Two Vermeers bring another chapter to a close.

The little boy by Goya is fascinating—with his birds and cats, one of which is suffering dreadfully from its repressed desire to spring. How did Goya manage to give his droll humour so much rein without dragging his pictures down to a plane of commonplace? Largely no doubt by fusing his tones in a manner more true to colour harmony than to life.

Two portraits by Velasquez, one of himself, the other of the Infanta Maria Theresa, seem to have the assurance with which the great man usually carries conviction of his grasp of personality as well as of every aspect, aesthetic, ceremonial, or psychological, of the problem in hand

Of the ten French pictures we are most likely to be arrested by the Watteau, The French Comedians, once in the collection of Frederick the Great. It has a hardness of design too seldom found in glamorous productions of the baroque century—so intellectual in its other manifestations The English portraits are fine and characteristic

THE ENGLISH HERITAGE SERIES Edited by Viscount Lee of Fareham and J. C. Squire. London Longmans, Green and Co 3s 6d each
SHAKESPEARE By John Bailey
ENGLISH WILD LIFE By Eric Parker
ENGLISH HUMOUR By J. B Priestley
THE ENGLISH PUBLIC SCHOOL By Bernard Darwin

These four little books are the first of a series dealing with the past of this country. They are attractively produced by Messrs Longmans, and they should both supply and help to create a demand for retrospective essays we are well supplied, nowadays, with threats, promises and prophecies relating to the future

In his general introduction, Mr Stanley Baldwin succeeds in doing what is commonly called "striking the right note" that middle C of picturesque, rural conservatism which is like an echo from a time before our modern discontents arose The future will indeed be depressing if it does not restore to us some of the joys of the past, withheld from a number of uneasy generations The design will be new, but let the content of the new world be congenial to the most human side of humanity; let us be more easy-going again, and get our food fresh and our pleasures at first hand

One can never envy the writer who undertakes a book on Shakespeare. The very freedom which such a subject permits is, in one aspect, a serious limitation. Writing

about Shakespeare, one is apt to reveal *oneself*, not the great man, whose universal sympathies (I am not speaking of his genius) were of a kind that remains rare to-day. Even Mr. Bailey does not succeed in refraining from, so to speak, *claiming* Shakespeare for a particular group. He practically assures us that Shakespeare had a rigid belief in the sanctity of marriage laws. And here is a curiously difficult sentence, expressing a view of another side of the poet's personality. "It seems impossible to doubt that Shakespeare was not at all what is now called democratic in his political or social sympathies There is nothing surprising in that: very few people were in those days." Does Mr. Bailey mean "very few people," or "very few people *who mattered*"? Of course Shakespeare disliked mobs: but does the anti-democrat court them less than the democrat? And does the democrat *like* them, or does he want to raise them from their condition because he has a sense of justice? The devil can quote Shakespeare as well as Scripture, so we are well advised to keep open minds about the poet's character, and not make sure that he would have felt more at home in one or another section of the modern community, had he been born again.

In Mr. Parker's "English Wild Life" not only English, but also Welsh and Scottish countryside and waters are described with tenderness, and a fear we may feel at the outset is quickly dispelled by sentences like this: "To me, at all events . . . . the pheasant is not first and foremost a bird of the table He is a bird of April . . . ." Before this we have read: "I shall never lift a rifle again at a stag . . . ." After all, the English have led the modern world in humanitarianism, and there is nothing un-English in showing more love of animals than of sport Mr. Parker's manner is reflective rather than boisterous, and this quietness makes his book, which is full of perfectly relevant information, agreeable reading for those who do not entirely share his interests as well as for those who will be warmed by the recital of their familiar joys.

When Mr Priestley speaks of the humour of Shakespeare and Dickens he is doing his duty as a recorder, these two great men are ever "best sellers," and need no recommendation. But Peacock, Marryatt and Surtees are not read half as much as they should be Mr. Priestley might have insisted more strongly on their remarkable qualities. Peacock he admires, without apparently quite understanding him, or recognising the force of his irony. Is there no seriousness in the words of Mr. Escot, the Deteriorationist when he says, speaking of material progress: "Profound researches, scientific inventions to what end? To contract the sum of human wants? To teach the art of living on little? . . . . No, to multiply factitious desires . . . . to invent unnatural wants . ." However, Peacock was too civilised to wish to force on his readers conclusions they could not draw for themselves from his arguments, and so he is usually accounted no more than a witty and amiable stylist. It is good to be reminded by Mr. Priestley that Marryatt was not simply a writer of books for boys Professor Saintsbury has tried to make the same fact known to our seniors, and the "Oxford Book of English Prose" properly contains a marvellous passage out of "Peter Simple," an English classic which combines style with humour, and is *par excellence* the book of our navy.

Mr. Bernard Darwin writes delightfully well, reasonably, without passion His subject is not really a promising one, and he does not adopt the attitude that "the battle of Waterloo was won, etc," or indeed that all the triumphs of England and the Empire were won by our semi-Spartan, semi-Athenian public schoolboys. He does not altogether admire the grown-up schoolboy of fifty or sixty, who, in fact, when not tiresome, is pathetic. It seems curious that so many public school-

masters should be drawn straight from the universities, having had no experience, or practically none, of the wide world outside the academic circle.

One of Mr. Darwin's chapters deals with famous Heads. The picture of Almond of Loretto is most interesting Almond was superb: but did he not miss his true vocation? I can offer no suggestion as to what this might have been. Only one may be allowed to feel that it is better for the young to attend schools where they can "scramble themselves" (Jane Austen's words) into a little education, than schools where their imagination is dominated by one man's personality. A little learning is less dangerous than much enthusiasm. It is all too easy to impress children: far harder to encourage them to think independently. But this is what schools should do.

MEETINGS OF THE SOCIETY

Ordinary Meetings.

December 11.—Major Charles Wheeler, O.B.E. (Mil.), M.I.A.E., formerly Chief Automobile Engineer of the General Post Office, "Overheads and other Factors influencing Road Transport Costs from an Engineer's Viewpoint." John Maughfling, C.A., will preside.

January 8.—Shaw Desmond, "The Novel What it is and what it is not."

January 15.—Joseph Burton, A.R.C.Sc.I., of Pilkington's Tile and Pottery Company, Ltd., "Quality in Pottery." Professor. H. E Armstrong, Ph.D., LL.D., D.Sc., F.R.S., will preside.

January 22.—Gilbert Stone, Barrister-at-Law, Legal Consultant to the Advisory Council on Minerals of the Imperial Institute, "Observations on the Mining Laws of the British Empire" Sir Richard A. S. Redmayne, K.C.B., M.Sc., M.Inst.C.E., will preside.

January 29.—Sir Thomas Holland, K.C.S.I, K C.I.E., D.Sc., F.R.S., Principal and Vice-Chancellor of Edinburgh University, "The International Bearing of Mineral Products." (Trueman Wood Lecture).

February 5.—Sir William Clare Lees, O.B.E. (British Economic Mission to South America), "Some Aspects of the Question of Trade with South America." Sir Edward T. F. Crowe, C.M.G., Comptroller-General, Department of Overseas Trade, will preside.

February 12.—Holbrook Jackson, Editorial Director of "The Drapers' Organiser," "Colour Determination in the Fashion Trades." The Right Hon. Lord Ebury, D.S.O., M.C., will preside.

February 19. G. K. Chesterton. (Subject to be announced later.)

February 26.—Professor F. A. E. Crew, M.D., Director, Animal Breeding Research Department, University of Edinburgh, "Genetical Methods of Live Stock Development."

March 5.—Professor Arthur R. Ling, M.Sc., F.I.C., School of Malting and Brewing, University of Birmingham, "Brewing as a Branch of Science." Sir William Waters Butler, Bt., F.C.S., Past-President of the Institute of Brewing, will preside.

March 12.—Professor G. Elliot Smith, M.D., F.R.S., "The Human Brain."

March 19.—Hesketh Hubbard, R.O.I., R.B.A., "The Making of Prints."

Dates to be hereafter announced:

Charles E. Douglas, M.I.Mech.E., M.I.Struct.E. "Rice Cultivation and Treatment."

S. K. RATCLIFFE, "National Parks."

GRANVILLE BARKER, "A National Theatre."

W. KING WILSON, Rabbit Specialist, Harper Adams Agricultural College "The Economic Importance of Rabbit Produce."

INDIAN SECTION.

Friday afternoons at 4.30 o'clock.

JANUARY 10.—SIR BASIL P. BLACKETT, K.C.B., K.C.S.I., "The Economic Progress of India."

FEBRUARY 7.

MARCH 7.—G. H. TIPPER, M.A., F.G.S., M.I.M.M., late of the Geological Survey of India, "Recent Mineral Developments in India" (illustrated by lantern slides).

APRIL 4. LIEUT.-COLONEL SIR WOLSELEY HAIG, K.C.I.E., C.S.I., C.M.G., C.B.E., Lecturer in Persian, School of Oriental Studies, University of London, "The Maratha Nation" (Sir George Birdwood Memorial Lecture).

MAY 9.—DAVID CLOUSTON, C.I.E., M.A., D.Sc., "The Report of the Royal Commission on Indian Agriculture."

DOMINIONS AND COLONIES SECTION

Tuesday afternoons at 4.30 o'clock.

JANUARY 28.—SIR DANIEL HALL, K.C.B., D.Sc., LL.D., F.R.S., "Settlers' Problems in Kenya."

FEBRUARY 25.—

MARCH 25.—O. J. R. HOWARTH, O.B.E., M.A., Secretary, British Association for the Advancement of Science, "The Work of the British Association in relation to the Empire."

APRIL 29.—

CANTOR LECTURES.

Monday evenings, at 8 o'clock.

HAROLD WRIGHT (of Messrs. P. & D. Colnaghi & Co.), "Three Master Etchers: Rembrandt, Meryon, Whistler." Three Lectures. January 20, 27 and February 3

LECTURE I.—THE ETCHINGS OF REMBRANDT VAN RIJN, 1606-1669. Rembrandt's predecessors in etching. His earliest etchings. Etchings of beggars. The illustrations of Biblical subjects. The Landscapes. The portrait etchings. Influence of Rembrandt's work on subsequent etchers. Tributes to Rembrandt's genius as an etcher.

LECTURE II.—THE ETCHINGS OF CHARLES MERYON, 1821-1868. Meryon's parentage. His youthful voyage to the South Seas. Return to Europe. Initiation into painting and etching. Etchings after Zeeman. The Paris etchings. The Bourges and South Seas plates. The Portraits and other commissioned plates. Meryon as a Social Reformer and Poet. His death. Some tributes to his genius.

LECTURE III.—THE ETCHINGS OF JAMES McNEILL WHISTLER, 1834-1903. His student days. Etchings of Alsace and Paris. He comes to London. The Thames series. The Portraits and Landscapes in drypoint. The Transition Period. The First Venetian series. The second Venetian series. The Cameos. The Etchings of Touraine, Paris, Brussels and the Netherlands. Whistler's influence on the revival of etching. Some tributes to his genius.

ALFRED B. SEARLE, "Recent Improvements in Methods of Brickmaking." Three Lectures. February 17, 24 and March 3.

LECTURE I.—Bricks still the most pleasing of artificial building materials; some reasons for this. Hand-moulded bricks the most beautiful, but too costly and too difficult to produce for many modern requirements. Enormous quantities now needed yearly necessitate mechanical methods of production from many kinds of materials.

Modern methods for making bricks of plastic or potentially plastic clays—Plain Bricks—Rustic Bricks.

LECTURE II.—Methods for making bricks of clay, shales, and other slightly plastic materials. The Stiff-plastic Process—the Semi-dry Process—the Tunnel Kiln and its effect on Brickworks Design. Multi-coloured Bricks.

LECTURE III.—Methods of making bricks of non-plastic materials—Sand-lime Bricks. Slag Bricks. Clinker Bricks. Bricks from Colliery Tips. Cement or Concrete Bricks. Silica Firebricks. Magnesite Bricks. Zirconia Bricks. Sillimanite and allied Bricks. Conclusion.

COMMANDER F. G. COOPER, R.D., R.N.R., "Aids to Navigation." Three Lectures. March 24, 31 and April 7.

DR. MANN JUVENILE LECTURE

CAPTAIN C. W. R. KNIGHT, M.C., F.R.P.S., F.Z.S. Two Lectures. Monday, December 30, at 3 o'clock, and Wednesday, January 1, at 3 o'clock. Illustrated by Cinematograph Films.

LECTURE I. "The Golden Eagle."

LECTURE II. "Wild Life in the Tree-top."

Special tickets are required for these lectures.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 9... [illegible] at the Charing Cross Station Hotel, Strand, W.C. [illegible] p.m. Mr. J. A. Pickard, "The [illegible]."

East India Association, at Caxton Hall, Westminster, S.W. [illegible] p.m. Mr. [illegible], "[illegible] Movements in India."

Electrical Engineers, Institution of, Savoy Place, W.C. [illegible] p.m. Discussion on "To Earth or not to Earth," opened by Messrs. W. R. Rawlings and J. C. Gilbert.

At the University, Liverpool. 7 p.m. Lt.-Col. S. J. Monkhouse and Mr. J. C. Grant, "The Heating of Buildings Electrically by means of Thermal Storage."

At Armstrong College, Newcastle-on-Tyne. 7 p.m. Messrs. B. A. G. Churcher and A. J. King, "The Analysis and Measurement of the Noise emitted by Machinery."

Farmers' Club, at the Whitehall Rooms, Hotel Metropole, S.W. [illegible] p.m. Annual Meeting. Prof. K. [illegible] White, "Recent Developments in the Breeding and Management of Sheep in Great Britain."

Heating and Ventilating Engineers, at the Borough Polytechnic, Southwark, S.E. [illegible] p.m. Mr. [illegible], "Common and Uncommon Boiler Troubles."

Metals, Institute of, at 39 Elmbank Crescent, Glasgow. 7.30 p.m. Mr. G. L. Cassidy, "Melting Furnaces."

Surveyors' Institution, 12 Great George Street, S.W. [illegible] p.m. Mr. W. J. A. Bull, "The Landlord and Tenant Act, 1927, in Operation."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.30 p.m. Prof. R. G. H. Clements, "Road Engineering in its Relation to Road Transport."

Swiney Lecture on Geology, at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr. Douglas Allan, "Rocks as Record of Earth History." Lecture I. Sedimentation and Fossils."

University of London, at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen. Sir F. Maurice, "The Western Front, [illegible] from the Battle of [illegible] to the Battle [illegible]." Lecture I. The Situation in the Spring of 1918."

At the [illegible] School of Economics, Houghton Street, W.C. [illegible] p.m. Mr. E. H. Warmington, "The Debt of [illegible] Explorers to Ancient Discoverers." (Lecture IV.)

At University College, Gower Street, W.C. [illegible] p.m. Principal J. B. McEwen, "England in Shakespeare's Day." Lecture IV. Elizabethan Music.

At University College, Gower Street, W.C. 5.30 p.m. Mrs. [illegible] Davis, "How London became the Capital of England." (Lecture IV.)

TUESDAY, DECEMBER 10... Anthropological Institute, 52 Upper Bedford Place, W.C. [illegible] p.m. Messrs. T. A. Joyce and J. E. [illegible], "The Expedition of the British Museum to British Honduras, [illegible]."

Automobile Engineers, Institution of, at the King's Head Hotel, Coventry. [illegible] p.m. Dr. A. P. [illegible], "The Relative Safety of Mild and High-Tensile Steels under Alternating and Pulsating Stresses."

Electrical Engineers, Institution of, at the Hotel Metropole, Leeds. 7 p.m. Lt.-Col. S. J. Monkhouse and Mr. J. C. Grant, "The Heating of Buildings Electrically by means of Thermal Storage."

At the Engineers' Club, Manchester. [illegible] p.m. Dr. [illegible] Simpson, "Lightning." (Kelvin Lecture.)

Illuminating Engineering Society, at the Home Office Industrial Museum, Horseferry Road, S.W. [illegible] p.m. Discussion on "Problems in Illuminating Engineering."

Marine Engineers, Institute of, 85-88 The Minories, E.C. 6.0 p.m. Engineer Vice-Admiral Sir Robert B. Dixon, Presidential Address.

Mechanical Engineers, Institution of, at the Royal Metal Exchange, Swansea. 6.30 p.m. Mr. R. A. Wetheral, "Some Features of Municipal Accounts and Finance and their Bearing on Cost Accounts."

Metals, Institute of, at Armstrong College, Newcastle-on-Tyne. 7.30 p.m. Mr. W. J. Griffiths, "Nickel in Non-Ferrous Foundry Alloys."

Petroleum Technologists, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Mr. John Gillespie, "The Engineer in relation to the Petroleum Industry."

Philosophical Studies, British Institute of, at the Royal Society of Arts, Adelphi, W.C. 8.15 p.m. Mr. G. Lowes Dickinson, "The Value of Art."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. Sir B. Pares, "Russian History to 1861. Lecture IV—Serfdom."

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. B. Ohlin, "The Relation between International Trade and International Capital and Labour Movements." (Lecture I.)

WEDNESDAY, DECEMBER 11. Anthropological Institute, at the Portland Hall, Great Portland Street, W. 5.30 p.m. Prof. F. G. Parsons, "The Anthropological History of the Modern Englishman."

Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m. Mr. A. H. Barker, "The Heating of Buildings by Electricity off Supply Mains with special reference to the Problem of Heat-Storage and Off-Peak Loads."

Fuel, Institute of, at Burlington House, W. 6 p.m. Mr. W. D. Wylde, "The Coal Burning Art as applied to Steam Production."

Public Health, Royal Institute of, 37, Russell Square, W.C. 4 p.m. Prof. Dr. Winifred Cullis, "Speed as a Psycho-Physiological Factor in the Life of To-day."

Swiney Lecture on Geology at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr. Douglas Allan, "Rocks as Records of Earth History. Lecture II. Vulcanicity and Metamorphism."

United Service Institution, Whitehall, S.W. 3 p.m. Sir Edward Denison Ross, "The Situation in the Middle East."

University of London, at the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. B. Ohlin, "The Relation between International Trade and International Capital and Labour Movements." (Lecture II.)

At the London School of Economics, Houghton Street, W.C. 6 p.m. Lecture X on "Office Machinery."

At the School of Oriental Studies, Finsbury Circus, E.C. 5.15 p.m. Mr. W. Sutton Page, "The Greatest Bengali Poet of the XIXth Century: Madhu Sudan Datta."

At University College, Gower Street, W.C. 3 p.m. Dr. C. Pellizzi, "La Lirica del Paradiso." (Lecture VI.)

At University College, Gower Street, W.C. 5.30 p.m. Mr. D. Cockerell, "Bookbinding as a Hobby and as a Career."

At University College, Gower Street, W.C. 5.30 p.m. Mr. A. M. Wijk, "The Reformation Period in Sweden." (Lecture III.)

THURSDAY, DECEMBER 12. Aeronautical Society, at the Royal Society of Arts, Adelphi, W.C. 6.30 p.m. Dr. W. Rosenhain, "The Development of Materials for Aircraft Purposes."

Asiatic Society, 74 Grosvenor Street, W. 4.30 p.m. Prof. Dr. S. Langdon, "Results of the Excavations at Kish, Season 1928-9, by the Herbert Weld and Field Museum Expedition."

Chemical Industry, Society of (Chemical Engineering Group), at the National Smelting Co., Ltd., Bristol. Mr. Stanley Robson, "The Treatment of Flotation Concentrates preparatory to Zinc Smelting."

Chemical Society, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 5.30 p.m. Prof. Dr. H. Freundlich, "Surface Forces and Chemical Equilibria." (Liversidge Lecture.)

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. Messrs. L. A. E. Sekutowicz and A. Evain, "The Electrical Plant and Network of the Société Electrique de la Sidérurgie Lorraine." (Joint Meeting with the British Section of the Société des Ingénieurs Civils de France.)

Electrical Engineers, Institution of, at University College, Dundee. 7.30 p.m. Mr. A. F. Stevenson, "Cable Design."

Historical Society, 22 Russell Square, W.C. 5 p.m. Prof. G. S. Veitch, "William Huskinson and the Controverted Elections at Liskeard in 1802 and 1804."

L.C.C. The Geffrye Museum, Kingsland Road, E. 7.30 p.m. Mr. C. A. Hindley, "Veneering Past and Present."

Metals, Institute of, at 83 Pall Mall, S.W. 7.30 p.m. Messrs. D. F. Campbell and W. S. Gifford, "Metal Melting by Electricity." (Joint Meeting with Institute of British Foundrymen.)

At the Chamber of Commerce, Birmingham. 7 p.m. Mr. A. H. Mundey, "Die-Casting."

North East Coast Institution of Engineers and Shipbuilders, at the Cleveland Institution, Middlesbrough. 7.30 p.m. Mr. N. J. Lanam, "Modern Constructional Steel Work."

Oil and Colour Chemists' Association, at 30 Russell Square, W.C. 7.30 p.m. Mr. G. King, "Silicon Esters."

University of London, at Bedford College for Women, Regent's Park, N.W. 4.30 p.m. Prof. Eccles, "Montaigne" (in French). Lecture X.

At the London School of Economics, Houghton Street, Aldwych, W.C. 5 p.m. Prof. B. Ohlin, "The Relation between International Trade and International Capital and Labour Movements." (Lecture III.)

At University College, Gower Street, W.C. 5.15 p.m. Prof. J. E. G. de Montmorency, "Momentous Lawsuits and Trials in Various Countries from Classical to Modern Times." (Lecture V.)

At University College, Gower Street, W.C. 5.30 p.m. Dr. C. Pellizzi, "Cesare De Titta, poeta abruzzese."

Victoria and Albert Museum, South Kensington, S.W. 5.30 p.m. Miss Muriel Clayton, "Medieval Brasses."

FRIDAY, DECEMBER 13. Astronomical Society, Burlington House, W. 5 p.m.

Engineering Inspection, Institution of, at the Royal Society of Arts, Adelphi, W.C. 5.30 p.m. Captain B. H. Peter, "The Trend of Development in Railway Signalling."

Eugenics Society, at Burlington House, W. 8 p.m. Dr. C. C. Weeks, "General Morbidity."

Junior Institution of Engineers, at the Royal Society of Arts, Adelphi, W.C. 7.30 p.m. Inaugural Meeting. Sir Ernest W. Moir, Presidential Address, "Tunnelling by Compressed Air."

Malacological Society, at University College, Gower Street, W.C. 6 p.m.

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Prof. G. F. Charnock, "Bearings for Line Shafting."

Metals, Institute of, at the University, St. George's Square, Sheffield. 7.30 p.m. Prof. Dr. [illegible], "Physical Testing."

North East Coast Institution of Engineers and Shipbuilders, at Bolbec Hall, Newcastle-upon-Tyne. 7.15 p.m. Informal Meeting, "Is Sea Experience Essential in order to become a Good Marine Engineer?" introduced by Mr. Edmund Wilson.

Oil and Colour Chemists' Association, at Milton Hall, Deansgate, Manchester. 7 p.m. (1) Dr. Stern, "Fastness to Light." (2) Mr. C. D. O. Winslade, "Some Aspects of Colour Testing."

Royal Institution, 21 Albemarle Street, W. 9 p.m. Miss D. A. E. Garrod, "Cave Excavation in the Near East."

Swiney Lecture on Geology, at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr. Douglas Allan, "Rocks as Records of Earth History. Lecture III. Tectonics and Earth Structures."

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof. H. B. Charlton, "The Comic Idea in Shakespeare."

At King's College, Strand, W.C. 5.30 p.m. Prince D. S. Mirsky, "The Russian Drama. Lecture IX.—Post-Revolutionary Drama and Cinema."

King's College, at 40 Torrington Square, W.C. 5.30 p.m. Dr. O. Odlozilik, "Outlines of Czechoslovak History.—I. Lecture IV. The Hussite Movement."

At University College, Gower Street, W.C. 5.30 p.m. Dr. Jal Dastur C. Pavry, "The Religion of the Parsis." (Lecture II.)

SATURDAY, DECEMBER 14. L.C.C., The Horniman Museum, Forest Hill, S.E. 3.30 p.m. Miss M. A. Murray, "Witchcraft."

JOURNAL OF THE ROYAL SOCIETY OF ARTS

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

NOTICES

DR. MANN JUVENILE LECTURES

Under the Dr. Mann Trust, CAPTAIN C. W. R. KNIGHT, M.C., F.R.P.S., F.Z.S., will give two lectures for children on "The Golden Eagle," and "Wild Life in the Treetops," at 3 o'clock on Monday afternoon, December 30th, and at 3 o'clock on Wednesday afternoon, January 1st. The lectures will be illustrated by cinematograph films. The syllabus of the two lectures is as follows:

LECTURE I (December 30th).—THE GOLDEN EAGLE. Romance of the Highland king of Birds—three eyries. The Adventures of William and his sister. The Crowning Climax. Slow motion film of Golden Eagle's flight. The liberation of Captain Knight's trained Eagle in Sutherlandshire.

LECTURE II (January 1st).—WILD LIFE IN THE TREETOPS. Close hand observations (pictures) of some of Britain's most dramatic birds in their tree-top homes—Herons, Hawks, Owls, Woodpeckers as shewn in intimate studies. The pictures taken from an observation post on the swaying treetops are of exceptional beauty and thrilling interest.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

FIFTH ORDINARY MEETING

WEDNESDAY, DECEMBER 4th, 1929. SIR LAWRENCE WEAVER, K.B.E., in the Chair. A paper entitled "The Advertiser and the Disfigurement of Town and Countryside: Criticisms and Suggestions," was read by MR. H. HARRY PEACH, Hon. Secretary of the Exhibition Committee, Council for the Preservation of Rural England.

The paper and discussion will be published in the *Journal* dated December 20th.

PROCEEDINGS OF THE SOCIETY

FOURTH ORDINARY MEETING

DR MANN LECTURE

WEDNESDAY, NOVEMBER 27, 1929

DR. S. SINNATT, M.B.E., F.I.C., M.I.Min.E., in the Chair

THE CHAIRMAN said that the subject upon which the lecturer was going to speak was the X-ray examination of coal and coke. Mr. Norman Kemp was a pioneer in this particular branch. He had been faced in the past with very great difficulties for two reasons, first, the difficulty of the technique of X-rays as applied to coal, and secondly, the absence of knowledge with regard to the structure of coal itself. The Society would also give him a special welcome as the Secretary of the Royal Scottish Society of Arts.

The following lecture was then delivered:

THE EXAMINATION OF COAL AND COKE BY X-RAYS

By C. NORMAN KEMP, B.Sc., F.R.S.E., Secretary, Royal Scottish Society of Arts

The present occasion is invested with more than ordinary interest for me on account of my official connection with the Royal Scottish Society of Arts, which, though considerably younger than the Royal Society of Arts, has consistently endeavoured since 1821 to promote similar objects. These were, perhaps, better expressed by the original title "The Society for the Encouragement of the Useful Arts in Scotland."

I esteem it a high honour and privilege to be afforded this opportunity of presenting to the senior Society a brief survey of the work which I have carried out in a very small corner of the vast field of Fuel Technology.

In 1921 and 1925 Cantor Lecture courses dealing with X-rays were delivered by Dr. G. W. C. Kaye and Dr. V. E. Pullin respectively, and towards the end of the latter year Dr. R. Lessing presented a Cantor Lecture course on the subject of Coal Ash and Clean Coal.

I am therefore in the extremely fortunate position of finding that my small corner of the field has already been tilled by three distinguished Scientists with each of whom I have had the pleasure of discussing various aspects of the subject which forms the theme of the present lecture. My rôle, therefore, seems now to be that of harvester, and I hope to be able to show that results of a certain scientific interest, and possessing possibilities of practical application, await the reaper who has sown the seeds of research on the combination "X-Rays and Clean Coal."

It would be superfluous for me to dwell at any length either on the production and properties of X-rays or on the ordinary and well-known characteristics of coal,

but I may be permitted to remind my audience of certain considerations which have an immediate bearing on the subject from the new point of view which obviously results from a direct mode of examination involving the inner structure of an opaque substance.

The outstanding and medically familiar attribute of X-rays which renders them of such extraordinary value in diagnosis, is their ability to penetrate all matter. This penetration is accompanied by partial or total absorption, and emergent radiation may be made to exhibit characteristics related to variations in the matter through which the beam has passed. The investigation of the emergent radiation may be carried out in two principal ways. It may be received on a fluorescent screen when the degree of fluorescence provides a visible differentiation of the field of view which constitutes a shadow picture of the structure of the specimen. If a photographic plate be substituted for the screen, an exposure results in changes in the emulsion similar to those produced therein by ordinary light, and on development, a negative is obtained which exhibits density gradations corresponding and proportional to the luminosity variations where a fluorescent screen is employed.

Prior to the War, Radiology may be said to have been a specialised subject within the sphere of medical practice. During and since the War, the applications of X-Rays in non-medical directions have steadily increased in number and importance. To such an extent is this the case that it is now not merely possible, but altogether desirable to subdivide the whole Science into two branches—Medical Radiology, and Technical Radiology without any suggestion of equality either as regards scope or importance.

Dr. Kaye has already addressed you on "X-Rays and their Industrial Applications," and a perusal of his book on this subject, published in 1922, provides ample proof of the already vigorous growth of the younger branch of radiological science.

I wish now to reproduce a short quotation from the Second Cantor Lecture on The "History of Radiological Research" by Dr. Pullin.

"Let us now consider the present position and try to understand exactly what modern research on apparatus is aiming at. I intend to exclude all reference to that highly important aspect of the subject its medical applications.

1. We will first decide what we want X-Rays to do.

2. Then we will see what apparatus we have at present and whether it will do it.

3. Then we must determine what apparatus we want and whether we shall be able to get it.

What do we want X-Rays to do? We want radiology to be the *indispensable adjunct* to all engineering practice. That will do for the moment.

X-Rays enable us to examine the interior of materials without in any way damaging or destroying them. That is a fundamental fact of the greatest importance."

Dr. Pullin is largely concerned with the penetration of material built up of heavy atoms, and he was able to announce in 1925 the successful penetration of four inches of steel, only 30 years after the discovery of the rays themselves

On commencing the examination of coal by means of Röntgen Rays a few years ago, I was naturally faced with considerations precisely similar to those quoted above.

A decision as to what the rays were required to do had been reached by earlier investigators, to whose work I shall refer later. With regard to existing apparatus, it was easy enough to improvise an equipment consisting of a source of electric current, an induction coil, and some sort of X-Ray bulb, and with it to carry out radioscopic (fluorescent screen) examinations, or to produce radiographic records of specimens.

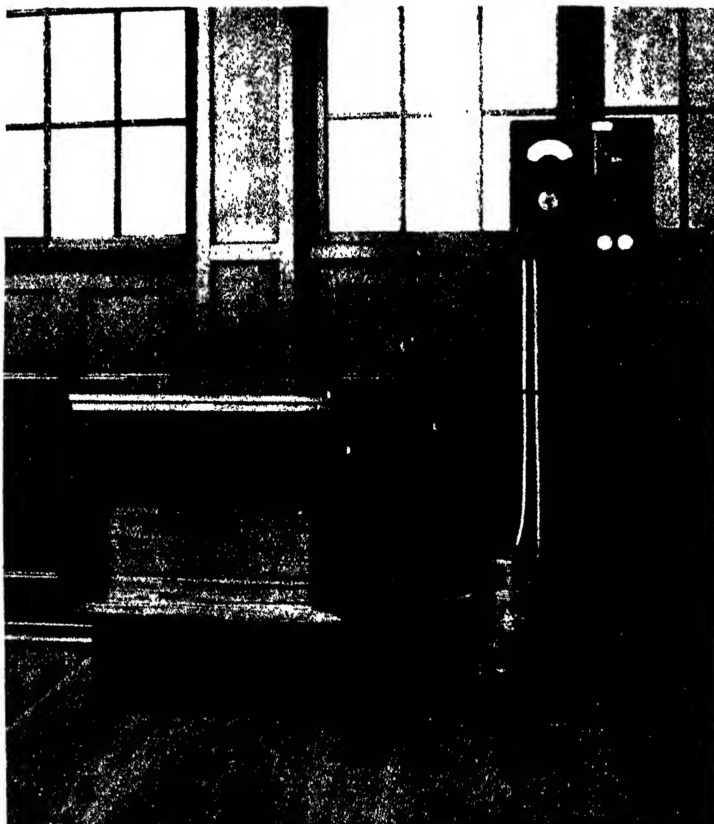


FIG. 1 'Carboscope" X-ray Unit

It was obvious, however, that real progress would demand the availability of less delicate, simpler, and safer apparatus, and I was then confronted with the consideration contained in Dr. Pullin's third heading the apparatus desired and its availability.

It will be evident that Manufacturers of X-Ray equipment are guided as to design by the requirements of their Clients, and as the Medical Profession provide

by far the largest Market, the apparatus which can readily be bought conforms to standards largely or even wholly different from those of the technical worker. For him the prime requirements are simplicity and safety, coupled with robust construction. In a word, an industrial X-ray unit should be as nearly as possible "foolproof." Without wishing to labour the point, I should perhaps add that none of the desirable characteristics mentioned are really lacking in medical X-ray equipment, but it must be borne in mind that such is destined to be used in therapeutic and diagnostic work on living people, and must therefore be provided with intricate accessories and adjustments which are wholly unnecessary where mere inanimate objects are to be dealt with.

I was fortunate in being enabled to co-operate with Messrs. Watson & Sons (Electro-Medical) Ltd., London, in the production of an X-Ray unit of a type suitable for coal research. This has been fully described elsewhere, but an example is shown in the accompanying photograph. The essentials—High Tension Transformer and X-Ray Tube—are contained in a lead-lined box from which the beam of rays emerges through a celluloid window upon which specimens may be placed for visual or photographic examination.

Normally, the "Carboscope" as we have called it, is connected to alternating current mains, and when this is possible, the equipment is devoid of moving parts and assumes its simplest possible form. When the electrical supply is continuous, a rotary converter becomes necessary, as shown in the photograph. The switchboard is naturally slightly less complicated in the case of the Alternating Current outfit.

Such equipment would be useless for the examination of plates of steel, and apparatus capable of the latter service would be quite unnecessarily large, elaborate, and costly for the examination of coal and similar substances.

Historical

Having thus indicated the nature of the radiographic equipment of to-day, and that formerly employed, it may be of interest to present a brief review of the work of the first entrants into the field of coal examination by means of X-Rays.

Until recently I was under the impression that the earliest work of this nature had been carried out in France, but a reference to the subject by Dr. Potonié in his "Einfuhrung in die allgemeine Kohlenpetrographie" led me to search out a short article in the "Zeitschrift für das Berg : Hutten : und Salinenwesen," where it is stated that the results of an X-Ray examination of more or less uniform sections of coal, and of sized products obtained from a coal-washing plant, had appeared in the periodical Der Kompass in November, 1897.

It is of no small interest to learn that the Mines Hospital at Sulzbach possessed thus early a Röntgen Ray installation, and it is equally remarkable to find it being so promptly applied to the investigation of washery products.

The research in question, under the title "Untersuchung des Aschengehaltes von Steinkohlen mittelst Röntgenstrahlen" revealed the now familiar appearance

presented by the "mineral skeleton" of coal, a term introduced by Couriot in his notable paper published in the following year.

Some of the results obtained at the Sulzbach Mine from dissections based on radiographic evidence, and followed by incineration of the various fractions obtained, are tabulated

		Darker parts	Lighter parts
Seam No	2	16.3%	3.4%
,, ,,	4	5.2	2.2
,, ,,	4	8.9	1.7
,, ,,	6	9.1	1.6
,, ,,	1	6.5	1.5

It appeared from these figures that the ash-producing matter in coal is often very unevenly distributed, and that some standardisation of method would be necessary in order to render possible comparisons between given pieces of coal and others of known ash-content.

The investigators at once perceived that suitable material was ready to hand in the "fines jig" of the Sulzbach coal-washer, and accordingly samples were taken differing widely in ash content, viz: 4.2%, 14.4%, 18%, and 36% respectively. These were dried, slightly powdered, and poured between glass plates held 1.5 cm apart in a frame. The different samples were separated from each other by small wooden blocks. The radiographs are reproduced, and show obvious differences in tone, but these are insufficiently marked to render possible a determination of ash content with the requisite accuracy, which, according to the writer of the article, should, in practice, be within one tenth of one per cent. The further observation is recorded that additional uncertainty results from the widely differing chemical character of ash producing materials, with correspondingly differing permeability to X-Rays.

With our increased knowledge of the conditions of radiographic work it is scarcely surprising that the pioneers of 1897 failed to establish a new analytical method, indeed it may at once be admitted that the problem attacked in Germany, France, and Belgium in 1897, 1898, and 1899 respectively has not yet been solved though hopeful lines of advance now exist and are under investigation.

In 1898 the Berliner Neueste Nachrichten published a communication in which Caryl D. Haskins of Philadelphia, claimed to have discovered that the calorific value of coal may at once be ascertained by examination with X-Rays. The claim is criticised as being far from simple, requiring more time than an incineration, and then yielding results of inferior accuracy. It is added that practical results are scarcely to be anticipated from an attempt to estimate the ash content of coal by X-Rays, but that, on the other hand, an important forward step may be made in purely scientific questions as to the distribution of the ash content in coal.

I have dealt with the foregoing historical investigations in some detail, as I am not aware of their having previously been brought to light in our Country

Reviews of subsequent papers by Courtot, Daniel, and Garrett & Burton are contained in my paper on the X-Ray Analysis of Coal, published in 1924, and I will confine my references to them to the exhibition of a few lantern slides

A very extensive study of Japanese coals has been in progress since 1920 by Iwasaki, and this worker uses X-Rays as an accessory method in his detailed microscopic examinations, as the detection of regions of special significance from his point of view is much facilitated thereby

In an early paper Iwasaki remarks

"The study of coal in Europe and America has already been made in detail to some extent, but the microscopic structure of Japanese coal, which is different from that of foreign coal, has so far been left uninvestigated We have some studies conducted by Makino and others by means of X-Rays, and some results of its investigation under the reflection-microscope by Kadokura.

The former chiefly aimed at knowing the amount of ash, and the latter at the origin of the coal, but neither gives us important aids for our fundamental study. This compelled the writer to take up the investigation for himself

Our present study is not to determine the species of plants of which coal was made, nor to trace its origin, but it particularly aims at discovering the internal structure of the coal and of making the steps of its development—from the original plants to the actual coal clear This investigation will naturally lead to the explanation of its origin Besides the discoveries on the scientific side we hope for other results from the investigation. Most of the gas-manufacturers, coke-makers, coal analyzers, and other chemists of to-day treat coal as a mass They think it is only a black block, but we shall prove that it is complicated in its structure and composition The investigation of it, we believe, will yield great aid to chemical technology."

* * * * * *

"Although some coal is so dark that any kind of light can not be transmitted through the thin sections, the transparent minerals, such as quartz and calcite, which are most frequently present in our coal, become visible of course under the microscope In spite of all the above mentioned extensions, opaque minerals such as pyrite, cannot be observed by the transmitted light And, moreover, although minerals may be quite transparent, if they are much smaller than the thickness of the thin sections, they are imbedded in the section and become invisible by the transmitted light, even when they can be seen on the surface of the coal. Thus it is necessary to have the light reflected from the polished surface of the coal.

In addition to the above mentioned, the X-ray is also applied in order to determine the nature and the arrangement of the mineral matters contained in coal. The thickness of the plates made for this purpose is between 1.24 mm. and 2.12 mm Photographs of them taken under the X-rays show very interesting figures. Sometimes the plates on which the pictures have been taken are examined under the microscope, and the forms of the mineral grains printed on the plates are observed, and, if needed, photographed on a magnified scale."

We may now proceed to consider the "black block" from the radiographic stand-point, and to inquire as to the nature of the information which is afforded by X-ray examination

Coal ordinarily is examined from the two aspects indicated in the description of the important work in progress under the direction of Dr. Sinnatt The Physical and Chemical Survey of the National Coal Resources.

Physical methods involve, *inter alia*, an examination of banded structure; the manner in which specimens tend to fracture; the characteristics of the different categories which result from a mechanical dissection of layers, and of mineral particles and the like, which are found in association with them. Individual pieces of coal may be reduced to such a thickness as to permit of their examination under the microscope by transmitted light; and methods of surface etching are also employed.

The only remark relevant in the present connection as to chemical methods of investigation, is that these involve the more or less complete destruction of the *physical* identity of the coal.

Although the point may lack practical importance, it is to be noted that radiographic examination involves no change whatever in the specimens subjected thereto. It may, therefore, reasonably be claimed that it should precede other methods of examination, as observations which result from radioscopic or radiographic inspection cannot but make some contribution to subsequent tests, each of which has its appropriate place and purpose.

A radiographic negative of a homogeneous material of uniform thickness exhibits a field of uniform photographic density. Such a result is rarely obtained in the case of coal, and it is this fact which lends to the method the value which it possesses.

Every variation in composition results in a corresponding variation in absorption, and consequently leads to radiographic differentiation. This is more or less distinct within the coal substance proper, but becomes highly diagnostic of included or associated mineral matter. In this way it is possible to distinguish in a specimen between regions which contain no visible discrete particles, and those where such particles are more or less abundant. Such particles, generally speaking, consist of, or contain, inorganic matter, and regions where they are absent, though not necessarily or even probably devoid of inorganic content, are described as pure coal substance, i.e., coal containing only " intrinsic " ash.

It may here be noted that the use of the word " ash " presents difficulties of description. As ordinarily employed the term refers to the product obtained after burning, or, from the laboratory standpoint, after incineration. In the present discussion " ash " has no place whatever, and yet it is difficult if not impossible to avoid reference to it, in view of the double meaning which it has now acquired.

According to the literature, coal containing only intrinsic, inherent, constitutional, or fixed " ash " signifies coal having its inorganic content so bound up within it that separation cannot be effected by any mechanical means. A further term has recently been proposed, viz., " minimum ash."

Extrinsic, extraneous, or free " ash " on the other hand refers to inorganic matter which can be distinguished in the form of discrete particles or in innumerable

other forms, and which can be separated by mechanical means from the coal with which it may be associated.

Radiographically, therefore, it may suffice to divide coal into two categories,—the coal proper, and the mineral skeleton,—as these are the two divisions primarily revealed by X-rays, and here the ash of the chemist obviously has no immediate place, though *potentially* present.

This point is emphasised by Dr. Kellett in his paper on the "Distribution of Ash in Bituminous Coal Seams," in which he introduces two new terms: "It has been found necessary," he writes, "in the present investigation to distinguish between the 'ash' existing in the coal prior to ignition and that remaining after incineration. The term *potential ash* is used to indicate the mineral matter in the coal before incineration, while the material remaining after complete incineration is designated *residual ash*."

It will be apparent from the lantern illustrations that a certain amount of information of a qualitative nature may be obtained from an examination of the radiograph of a particular piece of coal. This remains true even when both the thickness of the specimen and the conditions of the radiographic exposure exhibit considerable variations. It is clear, however, that a systematic investigation should be preceded by a standardisation of conditions not only as regards the specimens, but also in respect of the radiographic variables.

A method of preparing large coal sections having smooth, flat, and parallel surfaces was accordingly elaborated at H.M. Fuel Research Station, and I was then enabled to pursue the examination of a considerable quantity of new material and to institute comparisons amongst the resulting radiographs. The method of preparing the sections is described in detail, and a number of radiographic reproductions are given in my paper on "The X-Ray Examination of Coal Sections."

The next step in the main investigation related to the radiation, and involved an endeavour to define the conditions under which comparable radiographs may be obtained, as it might at first sight seem a simple matter to produce two identical radiographs of an inanimate object such as a block of coal. This work formed the subject of a paper entitled "The X-Ray Analysis of Coal: The Radiographic Variables and their Control," in which I enumerate twelve factors each of which plays its part in the process under discussion. These are as follows:

Relating to the Specimen.
- (*a*) Thickness.
- (*b*) Orientation.
- (*c*) Distance from radiating source.

II. Relating to the Radiation.
- (*a*) Penetrating power or "quality."
- (*b*) Intensity or "quantity."
- (*c*) Duration of incidence.

Radiograph of Coal Section (Full Size

III. Relating to the X-Ray Film.
  (*a*) Type of film.
  (*b*) Composition of developer
  (*c*) Temperature of developer
  (*d*) Time of development
IV. Relating to the Final Reproduction
  (*a*) Method of printing from negative.
  (*b*) Method of Reproduction from Positive.

The conditions under headings I and III are readily standardised, and those arising under heading IV need not be considered. We are thus concerned mainly with the emission from the X-Ray tube. It is comparatively easy to arrange for the substitution of one film by another without displacement of the specimen; to ensure that the two films used possess identical photographic characteristics; and to carry out development in such a way that no differences will result purely therefrom. It should then merely be necessary to adjust the apparatus so that an appropriate current flows through the tube, and to make successive exposures of identical duration.

If this be done with a "Gas" tube installation, it will prove practically impossible to secure two identical negatives, and while the use of a hot-cathode X-ray tube vastly increases ease of control, it does not wholly eliminate the difficulty, and even then it is essential to "run" the tube for a period sufficiently long to ensure stability and constancy of output before the desired exposures are made.

It is thus necessary to go even further than Castelli who remarks, evidently from experience, in a paper published in 1925, that "two radiographs cannot be compared with each other excepting when they have been made by the same operator, with the same apparatus, and by means of exposures of identical duration."

The foregoing details are given in order to show that while the production of a coal radiograph is a perfectly definite operation, it is not by any means so easy to obtain consistent and comparable results as earlier investigators evidently imagined. In many cases the refinements indicated may be dispensed with, but in at least one important operation (stereoradiography), they are essential.

Let us now briefly consider the appearance presented by a coal section which has been prepared and radiographed in the manner described. It will first be observed that an elaborate banded structure is present in this particular case, and that the number of bands or layers is probably greater than that apparent from a visual examination. Each radiographically distinguishable layer represents a change in composition, and the possible significance of these changes both from the physical and the chemical points of view is of sufficient importance to be made the subject of further inquiry.

I may quote briefly from a recent paper by Dr. Sinnatt, entitled, "Some Fundamentals of the Carbonisation of Caking Coals: The Formation of Cenospheres," with reference to a particular coal section which was prepared at H.M.

Fuel Research Station, and later subjected to mechanical dissection there in accordance with my radiographic evidence :

> "The coal, which was 8 inches of the thickness of the seam, was cut into a slab $\frac{1}{2}$ inch thick, and the layers seen in the (X-Ray) photograph are the inorganic constituents present in the separate narrow bands parallel to the bedding planes. When the photograph had been obtained the actual piece of coal was carefully dissected, and the chief layers, of which 21 could be recognised, were separated and the percentage of ash present determined, together with the amount of iron. The results show the great variation in the amount of ash present, and the fundamental differences in composition as can be judged by the percentage of iron. Lessing and Cobb and their associates have proved conclusively that the inorganic constituents have a profound influence upon the yield of products obtained during carbonisation, and also upon the structure and properties of the coke obtained. In view of this each individual layer in the above typical piece of bituminous coal may yield coke possessing definite characteristics, and quite distinct from its neighbour.

These radiographs also show very clearly the way in which the coal is traversed by numerous thin veins of mineral matter having a general direction perpendicular to the bedding planes of the coal.

Among other appearances, examples of tiny "faults" are to be observed in these structures, and not least in interest are the regions which have been *more easily* penetrated by the X-Rays than the *purest* coal present, and which, therefore, probably represent minute fissures in the coal from which the inorganic content has been removed in solution. These appear in the radiographic positive as thin lines which are white, or at least of a tone lighter than that of the purest coal present.

A discussion as to the probable origin of the vein and other structures as observed in some of my radiographs occurs in a paper by Prof. Henry Briggs, "A Note on the Mineralogy of Coal as suggested by X-Ray Examination."

Limitations of space forbid more than a passing reference to preliminary experiments designed to lead to the measurement of the photographic densities of standardised radiographs in terms of a recognised density scale. This becomes a question of photometry, and the work is not yet sufficiently far advanced to warrant further mention.

I have also in view the working out of a practical means of effecting a qualitative determination of the commoner minerals occurring in larger masses in coal, by the use of X-Rays of appropriate "hardness." In this way it should be possible both to detect and to distinguish, for example, between plates of quartz, calcite or pyrite even when completely invisible at the surface of the specimen.

In conclusion of the more academic part of the subject, I would refer to an interesting method of X-Ray examination which has been applied by my colleague Mr. Leslie Thomson, and myself to the examination of coal and coke, which both from their heterogeneous nature, provide outstandingly suitable material for the purpose. I refer to the stereoscopic technique whereby two radiographs of a specimen are made on separate films which are then viewed in an instrument which

enables the observer to examine the coal or coke as if it were a transparent or translucent mass.

In the case of coal the combustible portion yields a more or less undifferentiated solid field, within which, according to size, shape, density, and distribution, may be seen the mineral matter present.

Apart from its scientific interest, this procedure has its value in the fact that a radiograph of a section may exhibit a region where the total radiographic density at the point under consideration is not that due to the coal plus a particular mineral mass contained within it, but is due to the coal plus two such masses so disposed that they have been radiographically superimposed. In such an instance, as in many others, a single negative would lead to misinterpretation, whilst a stereoscopic pair would at once space out the two inorganic masses involved, and exhibit them in their actual relative positions in space.

Stereoradiographs of coal and coke provide curious and interesting objects for examination, and a more extended study of this comparatively little known branch of the main subject has been carried out under my direction by Mr. Arthur N. Wilson, whose paper on "The X-Ray Stereoscopic Examination of Coal," is in the Press, and will provide details of the actual technique.

Turning now to practical considerations it will be recalled that the first recorded application of X-Rays to coal examination related to products from a coal-washing plant.

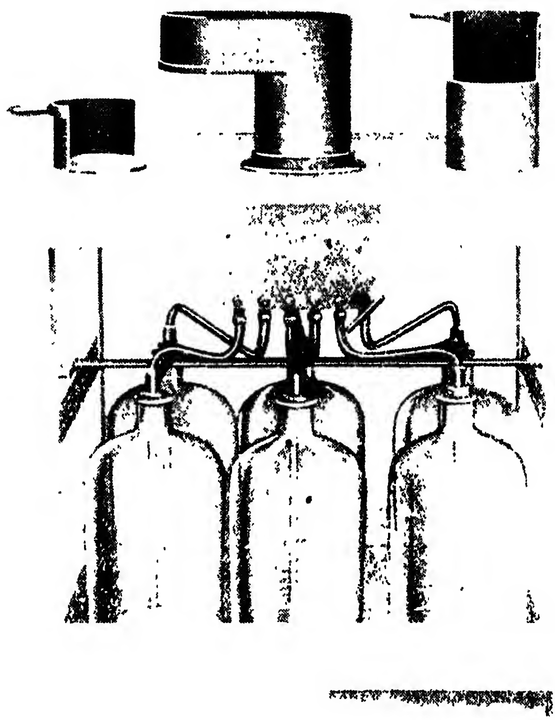
The preparation of coal for the market, which embraces "washing" by numerous familiar methods, or "cleaning", when the process employed is a dry one, formed a considerable part of the subject-matter of Dr. Lessing's second Cantor Lecture on Coal Ash and Clean Coal. This question is one of such outstanding importance that it is worth while to enquire if X-Rays can usefully be employed in connection therewith.

In 1925 Mr. William McLaren published a paper on the Scientific Control of Coal-Washing by the Combined Application of Ash-Characteristic Curves and X-Ray Examination, in which he showed, *inter alia*, the advantage offered by the latter method in facilitating the establishment of the end points of washability curves. An investigation on these lines has not yet been fully followed up, and should provide a fruitful field for further study.

This is referred to in the newly-issued Report of the Fuel Research Board for the year ended March, 1929, in which it is stated that "The application of the (X-Ray) method to coal-washing, for example, should prove of value. An X-Ray examination of the coal to be cleaned may reveal the amount of "inherent" or "constitutional" ash (derived from the original plant *débris*) which, because of its fine state of division, cannot be removed by washing and will therefore decide the minimum ash content obtainable in the clean coal. From a study of the so-called "extraneous" ash it may be possible to determine the size to which the particular coal should be crushed to ensure the most effective cleaning."

Referring once again to Dr. Lessing's second Cantor Lecture, we find under the heading, "The Control of Coal Washing and Cleaning Processes," the following:

"The various processes used or proposed for the improvement of the quality of coal depend on physical laws the theory of which in many cases still remains somewhat obscure. The amount of truly scientific research done on these questions is very small compared with the values involved. A first requirement for improvements in the preparation of coal in general, and washing and cleaning



Fl[illegible] Sink Apparatus.

processes in particular, is a more extensive and more efficient control of existing plants. Many of these are run without chemical control, in others such control is of a casual and spasmodic character. The principal method of controlling the work of a coal washery is to submit the products to float-and-sink tests and to estimate the ash percentages in the fractions thus obtained. Attempts have been made from time to time to apply mathematical treatment to the results obtained, but generalisations as to the degree of washability of coals usually fail on account of insufficient knowledge of the kind, relative proportions and distribution of the impurities."

These and other considerations have led to the use of X-Rays in conjunction with float-and-sink methods, and Mr. Leslie Thomson has carried out a number

of X-Ray studies of the successive fractions obtained as the result of a float-and-sink analysis, the latter operation being conveniently carried out by means of the apparatus designed by us, and shown in Fig. 3.

The results are interesting and in more than one instance have served to throw a considerable amount of light on difficulties which were being experienced in practice where coal containing "middlings" was involved.

Radiographs of two pieces of this character are shown in Figs. 4 and 5. In each case the coal present has a certain amount of shale associated with it, and the effect both of its presence and of its removal is shown in the accompanying "Ash Distribution Analysis."

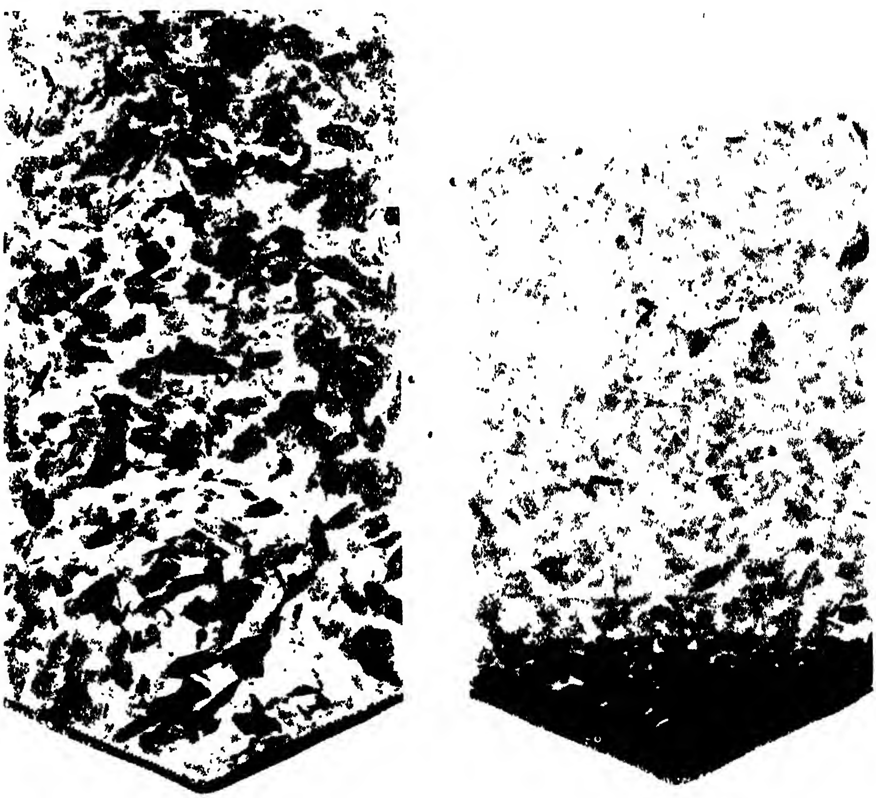
Number of Sample	Proportions of Coal and Shale %		Ash Contents of Coal and Shale %		Average Ash Contents of Sample		
	Coal	Shale	Coal	Shale	Total %	Due to Coal	Due to Shale
Fig. 4	67.7	32.3	2.47	49.5	17.67	1.67	16.0
Fig. 5	57.8	42.2	12.8	75.7	39	7.4	31.9

FIG. 4.—Radiograph of Coal.

FIG. 5.—Ra

The point of special note is the relatively *large* increase produced in the *average ash content* of each piece by a comparatively *small* proportion of shale, owing to the characteristic high ash content of the latter. In such cases very slight crushing ensures an almost perfect separation of coal and shale.

A further technique which has been developed by Mr. Thomson, not in connection with the coal-washing process directly, but on behalf of buyers of small washed coal for Power Plants and the like, has evolved from earlier work in which a sample of coal is placed in a small "jig" and subjected to the action of intermittent water pressure in exactly the same way as in a large-scale washing



(*a*) (*b*)

FIG. 6.—Radiographs of Sized Coal (*a*) before and (*b*) after Jigging.

box. If the sample is examined by X-Rays before and after jigging, the first radiograph will exhibit a more or less uniform mixture of all the pieces present of whatever composition. The radiograph obtained after jigging, on the other hand, will present two layers if any heavy shaly matter remains in the sample, despite the large scale washing to which it has previously been subjected. The

depths of the two layers are proportional to the quantities of the two categories present — clean coal above, and shaly matter beneath.

This method of test is described in my paper on the "Application of X-Rays to the Laboratory Jig-testing of small Coal," but the jig there illustrated has since been modified by Mr. Thomson, who now employs the form shown in the accompanying photograph.

It will be appreciated that the mere X-Ray inspection of a sample after jigging will, without proceeding further, provide a remarkably good guide as to the freedom of the sample from shaly matter which should have been removed at the washery.

In these days of specialisation in Plant manufacture it is not only possible, but easy, to obtain equipment which will clean small coal continuously and consistently down to within less than one per cent. of the "fixed" or "inherent" ash. How nearly this condition is sometimes met in practice may be judged from some figures obtained by Mr. Thomson from a series of periodical tests made on supplies of small coal for a large industrial Boiler Plant.

ASH DISTRIBUTION ANALYSIS.

Number of Sample.	Proportions of Coal and Shale. Coal	Shale	Ash Contents of Coal and Shale. % Coal	Shale.	Average Ash Content of Sample. Total. %	Due to Coal %	Due to Shale %
1	92.9	7.1	5.4	74.5	10.5	5.0	5.5
2	96.2	3.8	4.1	81.2	7.1	4.0	3.1
3	98.8	1.2	6.4	77.3	7.2	6.3	0.9
4	92.5	7.5	6.3	75.2	11.4	5.8	5.6
5	93.3	6.7	5.9	81.0	10.9	5.5	5.4
6	100.0	0.0	3.5		3.5	3.5	0.0
7	94.7	5.3	5.3	79.2	9.2	5.0	4.2
8	91.5	8.5	4.6	77.0	10.8	4.2	6.6
9	95.7	4.3	5.1	79.4	8.3	4.9	3.4
10	92.5	7.5	5.4	79.2	10.0	5.0	5.0
11	98.0	2.0	5.9	77.1	7.3	5.8	1.5
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

It is evident from the figures that the cleaning plant is able, on occasion, to lower the shale content to a reasonably low value, but that on the average it fails to do so. Further, there emerges the surprising fact that the average ash content of the coal actually supplied as a [illegible] product could in many cases have been halved.

The significance of this result is apparent, and the information it affords enables coal buying departments to maintain a much closer check on delivery than is possible by [illegible] determinations alone. Thus, in addition to this latter figure, it is necessary to know how the ash producing matter remaining in the coal is distributed. The failure to appreciate this point commonly found on the part of coal buyers rather justifies Iwasaki's somewhat caustic reference to coal being considered as a "black block" which in the case under consideration

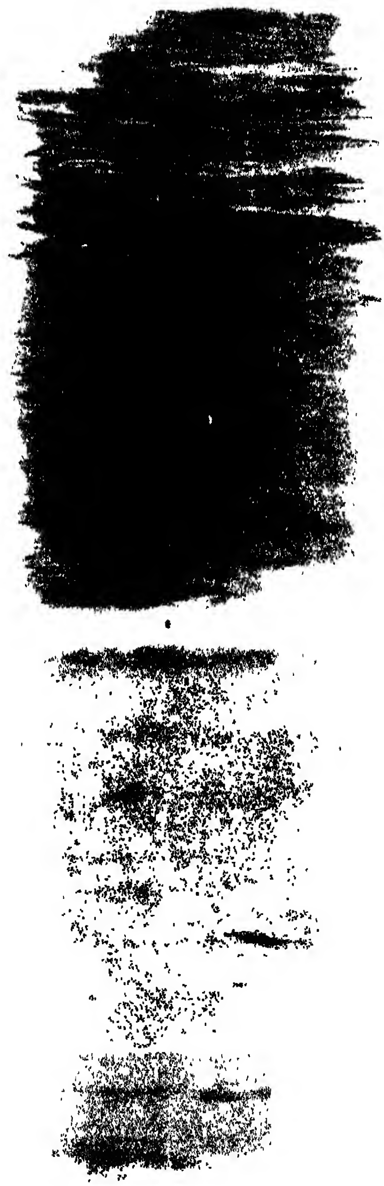


Fig. 7. Radiographs of Coal Core.

is equivalent to the belief that *average* results provide a true index of the value of the coal.

Various other practical applications will suggest themselves, but I will confine myself to the mention of one other—the examination of coal cores. When boring operations are carried out it is desired to obtain the maximum amount of information regarding the seams pierced, and prior to the destruction of portions, at least, of the core for purposes of chemical analysis, the preparation of a radiographic record seems a highly desirable preliminary.

By the kindness of Messrs. The Sullivan Machinery Company who provided me with portions of a 2" core, taken during prospecting operations in the North Midlands, I am enabled to reproduce the radiograph shown in the illustration.

In the present lecture I have confined attention to purely radiographic methods, but mention must be made of the diffraction phenomena which accompany the passage of a fine pencil of X-Rays through most forms of matter. When such a pencil of rays is received upon a photographic film after having traversed a material such as coal, various rings are found to have been produced. They vary in width and sharpness, partly in accordance with the X-Ray conditions, and partly as dependent on the particle size of the material.

An important study on these lines has recently been carried out in India by Mr. C. Mahadevan on the suggestion of Sir C. V. Raman, and the preliminary results are contained in a paper entitled "X-Ray Study of Vitrain and Durain and of their Constituents." It is indicated that much further work will be required before a full interpretation of the data becomes possible.

It appears that the fruits of further research along the lines now briefly indicated are likely to be worth gathering, and, reverting to the metaphor of my introduction, I hope that I may not be left to pursue my lonely furrow, but that others will enter the field and take part in the reaping which, according to Iwasaki, should "yield great aid to chemical technology."

In conclusion I wish to record my obligation to the Fuel Research Board of the Department of Scientific and Industrial Research, for a Grant which has enabled me to carry out most of the work which forms the subject of the foregoing review.

BIBLIOGRAPHY

The following list gives references to the Papers mentioned in the text, and includes also particulars of certain other publications bearing on the subject.

H. Couriot, "Examen et analyse des combustibles minéraux." *Bull. Soc. Ind. Min.* 12, 1898.

"Untersuchung des Aschengehaltes von Steinkohlen mittelst Röntgenstrahlen." *Zeit. für das Berg-, Hütten-, und Salinenwesen* 47, 1899.

J. Daniel. "Applications des rayons de Röntgen à l'examen des combustibles minéraux." *Ann. Mines Belg.* 4, 1899.

F. C. Garrett and R. C. Burton, "The Use of X-Rays in the Examination of Coal." *Trans. Inst. Min. Eng.* 62, 1911-12.

R. N. Field, "The Use of the Röntgen Rays in Palaeontology." *Iowa Jour. Sci.* 39, 1915.

C. Iwasaki, "A Fundamental Study of Japanese Coal." *Tech. Reports, Tôhoku Imp. University*, 1920-26.

F. Wever, "The Nature of Graphite and Temper Carbon." *Mitt. aus dem Kaiser-Wilhelm-Inst.*, 1922.

H. Briggs, "The Anthracite Problem." *Proc. S. Wales Inst. Eng.* 39, 1923.

C. Norman Kemp, "The X-Ray Analysis of Coal." *Trans. Inst. Min. Eng.* 67, 1924.

C. Norman Kemp, "The X-Ray Analysis of Coal, and a New X-Ray Examining Unit." *Jour. Soc. Chem. Indus.* 43, 1924.

Robert Potonié, "Einführung in die allgemeine Kohlenpetrographie." 1924.

William McLaren, "The Scientific Control of Coal-Washing." *Trans. Inst. Min. Eng.*, 1925.

Kemp and Thomson, "The X-Ray Examination of Coal." *Discovery*, 1925.

G. Castelli, "L'Impiego dei raggi Rontgen per l'esame dei combustibili fossili." *Rass. Mineraria* 63, 1925.

R. Lessing, "Coal Ash and Clean Coal." *Cantor Lectures*, 1925.

A. St. John, "X-Ray Studies of Coal and Coke." *Amer. Inst. Min. and Met. Eng.*, 1926.

C. Norman Kemp, "The Application of X-Rays to the Laboratory Jig-Testing of Coal." *Proc. S. Wales Inst. Eng.* 42, 1926.

F. S. Sinnatt, "The Preparation of Coal for the Market." *Fuel Econ. Review* 5, 1926.

C. H. Lander, "Recent Developments in the Science of Coal Utilisation." *Jour. Amer. Soc. Mech. Eng.* 49, 1927.

G. L. Clark, "Applied X-Rays." 1927. (McGraw-Hill Book Co.)

Thomson and Kemp, "The Float-and-Sink Testing of Small Coal: A New Laboratory Unit." *Jour. Soc. Chem. Indus.* 46, 1927.

O. Ruff, "Die chemischen und physikalischen Vorgänge bei Kohlensäureaus-bruchen." *Zeit. für das Berg-, Hütten-, und Salinenwesen* 75, 1927.

Fischer and Dilthey, "The Preparation of Pure Carbon at Low Temperatures." *Brennstoff-Chemie*, 1927-1928.

E. Stach, "Kohlenpetrographisches Praktikum." 1928. (Gebr. Borntraeger.)

R. van Aubel, "La détermination à l'aide des rayons X des minéraux, minerais et de quelques produits industriels." *Rev. de l'Industrie Minérale* 177, 1928.

C. Norman Kemp, "The X-Ray Examination of Coal Sections." *Proc. Royal Soc. Edin.* 48, 1928.

F. S. Sinnatt, "Some Fundamentals of the Carbonisation of Coking Coal: The Formation of Cenospheres." *Proc. Second International Conference on Bituminous Coal*, 1928.

H. Briggs, "Note on the Mineralogy of Coal as suggested by X-Ray Examination." *Trans. Inst. Min. Eng.* 77, 1929.

C. Norman Kemp, "The X-Ray Analysis of Coal: The Radiographic Variables and their Control." *Trans. Inst. Min. Eng.* 77, 1929.

DISCUSSION

The Chairman said he was struck by the importance of the method as a means of recording the variation of coal seams in different parts of the coalfields. Practically no systematic records had been made, and this was due to the fact that few methods were available for recording the structure of seams as they actually existed. In the past the method employed consisted in cutting thin slices of the seams and taking

photographs of the sections; it was then possible to compare seams from different points in the coalfields. It would appear that the technique advanced by Mr. Kemp was probably easier to apply because by viewing the layers of inorganic matter it would be possible to compare horizons and recognise similarities. The photographs would be permanent and a clear impression could be obtained of what was happening to a seam as one passed from one point to another in the coalfield

The photographs also afforded information upon the heterogeneous character of seams. At one time he had found it necessary to measure the thin layers in seams as a means of determining the percentage of dull and bright coal present. The measurements were made to the nearest millimetre, and in some of the seams about ninety layers were observed in a thickness of three feet. The audience would remember the slide shown by the lecturer of a piece of coal about 8 inches in thickness; if they took one particular inch of this it would be possible to count over 100 layers. This afforded an idea of the heterogeneous character of coal and the application of this knowledge was of importance in the use of coal as pulverised fuel and where coal was being carbonised as fine particles. It introduced something new into coal technology

DR. R. LESSING considered that one of the most significant points about Mr Norman Kemp's most instructive lecture was his reference to early work in this branch He had mentioned a hitherto unknown, or little known paper, published in 1897, which dealt with the radiographic examination of coal This threw a certain light on what they were always taught to believe was in fact existing, namely, progress in industry. It took thirty-two years from the time that paper was written before there was a recognition of the important methods of examination of coal which that early paper suggested That paper was written only two years after Rontgen's famous discovery, and the method was actually employed, but fell again into oblivion. He himself well remembered how a week or two after the publication of Rontgen's discovery he, as a school boy, obtained a copy of his paper, and it was one of his most cherished possessions The fact that mankind were rather inclined to regard their individual lives as more important than anything else led to the seclusion of the radiographic worker in medical circles, and the desire to study the "inner man" had practically monopolised X-ray work until a few years ago, since which time it must be admitted X-ray work for industrial purposes had progressed very considerably. Mr. Kemp and his associate, Mr Leslie Thomson, had been among the modern workers who had led the way.

With regard to the X-ray examination of the structure of coal, he was reminded of Goethe's saying that "blood is a most peculiar juice," and he would like to paraphrase that and say "Coal is a most peculiar stuff" The Chairman had already referred to the heterogeneous character of coal. This fact had been rubbed into all concerned *ad nauseam* during the last few years, and still it was necessary to work away in that direction in order to prove that in coal one had not to deal with a uniform substance. No method could show more conclusively that coal was of this heterogeneous composition, it composition it might be called, than the X-ray examination expounded to the Society by Mr. Kemp. It showed much more than any other form of analysis could do (unless such analysis were carried to the infinitely small particles of which they had heard), what was the position in regard to the particle of coal, the lump, and the seam. He thought that the stereoscopic effect obtained by Mr. Kemp and Mr Thomson was very wonderful. It showed actually the interior of a piece of coal without any necessity for touching it by means of chemical agents or otherwise. Here was a true ash skeleton revealed, without the need for touching or altering even the surface, let alone the interior. This was of immense practical

importance and not only of academic importance in the study of coal, on which Mr. Kemp, until almost the end of his lecture, had laid stress.

The lecturer had pointed out how readily processes could be controlled by this method, particularly the process of the cleaning of coal. There was no reason why in future the workman or charge-hand—if the collieries would not see their way to placing their coal-washing under the control of qualified chemists or physicists—should not have to his use an instrument sufficiently robustly made which he could employ without awaiting the result of analysis, and by which he would be able to control his processes and see what was actually happening. The work done by Mr. Kemp and his colleagues would be more and more appreciated. The industry was now in a position to clean coal in a commercial manner, but in order to do this it must have a ready means of ensuring that what could be done was actually carried out. The audience had seen on one of the lecturer's slides a comparison between clean and unclean coal—the former looked something like cotton wool—but it was necessary that the heterogeneous portions should be separated as they could be. Such work could be done, and the lecture just given would go very far to bring it home to those who ought to be interested in the subject that these methods should be and must be applied in a practical way. They would then be certainly a fruitful source of income, at all events to those who had to do with certain parts of the handling of coal, if not to the enthusiastic scientific workers who had initiated and promoted a knowledge of them.

MR. W. H. PATCHELL said that this had been a most entrancing lecture. His mind went back twenty-five years since he saw the first work by Mr. Lomax in Manchester. This was thought at that time to be wonderful, and certainly, under the auspices of Sir William Garforth, some masterly work for the coal industry was done. But he had not realised until he saw the lecturer's slides and projections why Mr. Frank Hodges had gone from coal into cotton! [This was an allusion to the cotton-like appearance of the cleaned coal shown in the slides.] He hoped that now he would stick to the cotton, and that the coal trade would follow his example and give the community something clean.

MR. ARTHUR GROUNDS said that this was a subject of very great importance from the point of view of those who supplied coal washing plant. It was particularly useful because they would desire to have a ready means of checking up the performance of a coal-washing plant in its early stages. Very often when a coal washing plant was put into operation, it did not get into its full stride within the first two or three days. If a method such as the one described by the lecturer were available whereby the washed product could be examined regularly every hour, or every shift, or every day, it would simplify the work of those taking over the washing plant, and would add to the information of those whose business it was to design such plants.

It might be thought in considering the examination of middlings, that X-ray analysis or examination was rather a refined way of doing a rough job. It might be considered similar to buying a racehorse to do donkey's work. But there were certain coals in South Wales—certain anthracites—which had on the surface a dull appearance, but immediately the coal was broken a band of brightness made its appearance running right through the centre. The only method of examining such coals was by X-rays. From the point of view of the coal producer, X-ray examination was particularly useful, because it indicated the size to which the coal would have to be crushed in order to yield clean coal, and showed the dirt which would have to be discarded. This had an important economic bearing, because certain grades and sizes of coal could be sold at much higher prices than others.

The truth was that at meetings such as the present there were enthusiasts who were keen on the development of these methods, and what he would like to see was that everybody present should carry home to the coal producers and those to whom these methods could apply, the benefits which they could furnish. It was of no use for Mr. Kemp and similar pioneers to do such work unless the value of it was brought home to those responsible for producing coal, those designing coal-washing plant, and those using coal. The application of the method should be brought home just as much as the research itself.

MR. G. K. MENZIES, speaking with reference to the remarks of Mr. Grounds, said that one of the main functions of the Society was to try to do exactly what he had said ought to be done. The Society endeavoured to be a sort of half-way house between the technical experts and the industrialists, and perhaps the chief part of its work was the publication of reports of meetings like the present in the *Journal*, which found its way to a large number of people who ought to be interested.

MR. W. H. PATCHELL recalled that the last time he was in the room, Mr. Llewellyn Atkinson spoke of what the Society had done since its foundation. It had lived up to the character given to it, and he hoped that this present occasion would give it a further stimulus.

MR. W. F. BAKER had one criticism to make about X-ray methods of analysis. It seemed to him that from a practical point of view they were far too sensitive. If one showed a colliery owner an X-ray photograph of a piece of coal and told him the dark patches were dirt, he would reply, "In that case it is not a bit of good my trying to get rid of the dirt." It used to be said that dirt was matter out of place but in the new dictionary the speaker thought that dirt would be defined as "A substance which used to be called coal." If it was desired to get rid of all the dirt it would be necessary to pulverise the coal down to more than microscopical fineness, and coal must be of a certain size, at any rate, to be of any use. Would it be possible to pulverise the whole of the coal, then clean it, and afterwards remake it into the size of double nuts? He also desired to know whether the lecturer had done any work on similar lines to that of Mr. C. Mahadevan, which he mentioned at the end of his lecture. The speaker rather thought that this work afforded definite evidence that the Alpha and Beta fractions of coal were quite definitely cellulosic in origin. He would like to have some further details of any work of that kind.

MR. ARTHUR GROUNDS asked what would be the cost of an X-ray apparatus such as the lecturer used, which would be robust enough to be supplied either to a firm of coal owners or a firm of coal-washing appliance manufacturers.

MR. HARALD NIELSEN said that after listening to Dr. Lessing's excellent lectures on coal cleaning, he was much taken with his X-ray apparatus and he had installed one for himself. With regard to the cost of apparatus for X-ray work on coal, he could inform the meeting that he purchased a 12 in. sparking coil for 52s., and an X-ray tube for 15s. He thought the whole apparatus, which was quite serviceable, cost him less than £4. It was a very rough and ready method of examining coal, but it was interesting, and when it came to the question of how much coal-people could afford to pay for X-ray apparatus, these figures which he had given might be useful. So common and cheap was X-ray apparatus that one could go into any bootshop and be fitted on the basis of the appearances of the foot shown by an X-ray fluorescent screen.

Mr. Norman Kemp, in replying on the discussion, thanked the speakers for their appreciation of his lecture. With regard to the remark about the sensitiveness of the methods employed, this was undoubtedly true. He had refrained from repeating the remarks of one coal-owner to whom a particular X-ray photograph was shown, because they would not bear repetition. This owner wanted the photographs completely suppressed.

With regard to the diffraction methods of analysis, he had not had any opportunity of pursuing the lines of the Indian research to which reference had been made. A certain amount of work had been done in other countries, not so much on coal, as on pure graphite.

With regard to the cost of equipment, this depended to some extent upon the source of electrical supply. If there was a direct current supply a rotary converter was necessary. The amount required for equipment, in round figures, might be £150, but with regard to the method mentioned by the last speaker, he might say that it was one which he had himself adopted, though he was not sure that his apparatus cost as little as £4. But it was necessary to impress upon all concerned the very grave risks incurred by using X-ray equipment in a casual way, and by placing it in the hands of routine workers other than those who were acquainted with the physical and biological conditions involved. It was necessary to work in strict conformity with the regulations of the X-ray and Radium Protection Committee. He did not know to what extent members of the audience had ever met those who were called X-ray martyrs, but he himself had met several, and there were few more tragic sights than a man who had lost fingers and limbs through injudicious exposure to X-rays. In these days there was no excuse whatever for such exposures. The methods of protection were thoroughly known and understood. But the use of improvised apparatus was certainly accompanied by great risk, unless it was used, say, once in two or three months, in which case it was almost of no practical utility. This question of protection was put in the forefront of the requisites, and the cost was partly governed by that consideration, namely, the need of providing something which was electrically safe, radiographically safe, and at the same time robust enough to do the work for which it was designed.

He wished to express again his gratitude for the way in which his paper had been received. The paper was no more than a review of progress up-to-date. It described a certain amount of work in a field which, as several speakers had indicated, held much further promise.

The Chairman said he would like to make an observation upon the cost of the equipment. The figure of £150 had been mentioned, but it must be borne in mind that when this sum had been expended the worker had done, to all intents and purposes, all his ash determinations. A constant supply of samples could pass over the instrument and the information was obtained instantaneously and adjustments could be effected, whereas when the samples were sent to the laboratory it took some hours for the report of the test to reach the washery. The sum of £150, moreover, represented the salary of a very junior chemist and instead of all the labour associated with the tests in the laboratory, one had an instrument which did the work for a relatively small outlay.

He wished to express on behalf of the Society very hearty thanks to Mr. Kemp for his delightful and interesting lecture.

The vote of thanks, having been proposed, was carried unanimously and the meeting terminated.

OBITUARY

THE HON. SIR JOHN COCKBURN, M.D., K.C.M.G.—Sir John Cockburn, who died on November 26th in King's College Hospital at the age of 79, had been a prominent figure in Australian circles in London for the past thirty years. Born at Corsbie, Berwickshire, on August 23rd, 1850, he was educated for the profession of medicine and took the degree of M.D. at London University. At the age of 25 he emigrated to South Australia and speedily interested himself in politics. He became Mayor of his town at the early age of 27, and later was elected to represent Burra in the State Parliament, where he played a prominent part, becoming Minister of Education from 1885 to 1887 and Premier in the years 1889-90. Later on, he held other offices, being Chief Secretary in 1892 and Minister of Education and Agriculture from 1893 to 1898, when he retired from political life to become Agent General for South Australia in London. He had been one of the South Australian delegates to the 1897-98 Federal Convention which was eventually successful in framing a Constitution, and in 1901 he read a Paper before the Society on "The Commonwealth of Australia," for which he was awarded the Society's silver medal. Subsequently he contributed Papers on "The Sphere of State Activity in Australia," "The Biology of Federation," and other subjects, and was also a frequent participant in the discussions at the Society's meetings. At the time of his death he was a member of the Dominions and Colonies Section Committee, on which he had served for many years.

NOTES ON BOOKS

INDUSTRIAL CARBON. By C. L. Mantell, Ph.D. (Pratt Institute, Brooklyn.) London: Chapman and Hall, Ltd. 21*s.* net.

Of all the elements, carbon impresses us most by the extraordinary variety of its industrial applications. Iron must no doubt be admitted to possess greater economic utility, and mercury might perhaps claim to excel in sheer versatility in the laboratory, but a short examination of this interesting volume will suffice to convince the reader that neither of these could equal carbon in the width of its industrial range.

To begin with, carbon has the advantage of existing in three different solid states—diamond, graphite, and a group of forms such as lamp-black, charcoal, gas-carbon, etc., which are usually classified together as "amorphous"; and its properties in these states are so different that one might almost be dealing with three different substances.

The author makes some attempt to keep his treatment of the three forms separate, but considerable overlapping is unavoidable. He begins, however, with a chapter in which the whole of the information on diamonds is concentrated. This, indeed, is not a great quantity, but it serves to illustrate the fact that much of the practical utility of carbon arises from the *extremeness* of its properties. Thus the diamond is the hardest of minerals, and is therefore extensively used in glass-cutting, rock-drilling and wire-drawing; it has also a quite abnormally high refractive index for light, whence it derives its eminence as a precious stone. It is shorn, however, of the supernatural physiological effects with which it was credited in early times; and if it can still claim to be "the peacemaker between husband and wife," the mechanism of pacification is not quite what was formerly supposed.

The softer forms of carbon, such as graphite and gas-carbon, owe much of their economic value to their possession, in an extreme degree once more, of the qualities of infusibility and incorrodibility, to which must be added the unique property of being at once a non-metal and a passably good conductor of electricity. This combination of three rare characteristics provides the foundation of the great carbon electrode industry. Economically, this is now probably the most important application of carbon, since the output of electrodes in the United States alone reaches an annual value of over ten million dollars, as against ten thousand dollars in 1899.

Carbon electrodes vary greatly, both in composition and method of manufacture, as is only to be expected when we remember the range of different purposes served by the electric furnace; electrolytic, when the current brings about the necessary chemical change, as in the manufacture of aluminium; "electrothermic," when the chemical change is caused merely by the high temperature attained, as in the manufacture of calcium carbide, carborundum and artificial graphite; and purely thermal, as when fusions and heat treatment of alloys constitute the objective. All these considerations, together with many others, are examined by the author in great detail in this section, which is probably the most valuable part of the book.

The qualities already specified, or some amongst them, account for the use of carbon in the form of electrodes for arc light; of contact-brushes for dynamos and electric motors, the American annual output for this purpose alone being valued at from six to ten million dollars; and of crucibles and furnace linings adapted to bearing the highest temperatures that we can produce.

Carbon next presents itself to us in an entirely fresh capacity, namely that of an adsorbent. Industrial adsorption may be briefly described as the removal of some substance from vapour or solution by inducing that substance to condense itself in the form of a film or skin on the surface of a solid adsorbent. For some reason, no doubt connected with its unusual power of breaking down into most minute particles, carbon is one of the most powerful adsorbents known. Amongst the earliest practical applications of this property was the use of charcoal for decolorizing crude sugar solutions: the solution is simply brought into contact with the charcoal, and the colouring matters are adsorbed to the surface of the latter. The same principle is now coming to be more and more used in the extraction of the precious metals from solution. Similar adsorbtion of substances from gases and vapours also received early application in the use of charcoal as a deodorant; but of course was raised to a high-water mark of importance by the war, when charcoal was widely used in gas-masks to remove poison gases from air before respiration. Very different forms of carbon are needed for these varying purposes, to which in more recent years has been added the recovery of valuable volatile solvents from mixed vapours; but the two main types are bone-black, produced by the high-temperature charring of bones; and vegetable chars, from various woods and woody substances. Excellent information, both practical and theoretical, is given in the chapters dealing with this subject.

In relation to this unusual capacity for sub-division is also the use of graphite as a lubricant: the soft soapy feeling of the substance is due to the extreme willingness of slip-planes to develop within the grains, which are thereupon further broken up, the upper parts sliding on the lower. A still further use of this important property, together with the deep black colour of soft carbon, is made in the pigment industry. Almost every printing-ink owes its blackness to carbon, either as lamp-black or some similar deposited black; and many other pigments and pigmented products contain graphite. Lead pencils, of course, are a case in point: "there is no dog in dog biscuit, nor lead in lead pencils," as our author remarks.

Lack of space will hardly permit reference to still further most important uses of carbon—such as its fuel-value and its position as an essential constituent of all the older steels—which receive treatment in the book. Though it is in some degree marred by certain faults both of method and of finish, the volume is nevertheless a valuable addition to the text-book literature, and will appeal to a large circle of readers.

An Introduction to Modern Organic Chemistry. By L. A. Coles, B.Sc. (Lond.), A.I.C., Senior Chemistry Master, Batley Grammar School. London: Longmans, Green & Co., Ltd. 7s. 6d. net.

While the last twenty-five or thirty years have brought about something like a revolution in the methods of teaching the more advanced portions of organic chemistry, it must be admitted and regretted that more conservatism has been shown in the matter of the student's first introduction to the subject. It is not easy to indicate in a few words the precise nature of the point, but it relates without doubt to the deeper and more graphic realization of the objective certainty which now attaches to our inferences concerning the structure of organic molecules. It would hardly be too much to say that the advanced student is encouraged to imagine the organic chemist as building up substances with a facility almost comparable with that of a boy building a model from Meccano parts, and with something approaching an equally clear picture of how the model is progressing. Needless to say, we are not concerned here with the problem of "ultimate reality," which is not one of the problems the scientific investigator sets himself to solve; all that is meant is that atoms and molecules are as real as (say) houses, and that the organic chemist's diagram of the positions of the atoms in the molecule will in many cases approach in reliability his plan of the rooms in his own house, and will stand in similar relation to ultimate truth.

Nevertheless, some inhibition appears to render teachers reluctant to present organic students with this information from the start. In the present text-book, written by a teacher of experience and enthusiasm, no structural formulas at all are given in the first eighty pages; in just the stage, that is to say, when the student may be assumed to be bewildered by the novelty of an unfamiliar subject, and to be most in need of a concrete pictorial representation. It cannot be that any doubt is felt as to the validity of structural diagrams, which are naturally used freely in the remainder of the book; while to suggest that they would confuse the new student is almost analogous to suggesting that the study of geography would be simpler if there were no maps. In short, one must hope that the time will come when it will be recognised that the formula C_2H_3OCl (used exclusively and frequently in this opening section), is not an easy, but an excessively difficult, representation of the acetyl chloride molecule.

Reference having been made to this fundamental difference of opinion, it remains to add that these eighty pages set forth in an able and very interesting manner the main elementary facts relating to ethyl alcohol and acetic acid, together with an account of the methods used in arriving at empirical and molecular formulas. The nature and derivation of structural formulas are then explained, and the rest of the book deals systematically with aliphatic and aromatic compounds, up to and somewhat beyond the standard usually demanded in a university intermediate examination.

The instructions for laboratory preparations contain features of unusual merit. The author's criticism, that such instructions follow only too often the early original papers dealing with the various substances, is well-founded, and his attempt to substitute where possible later and better methods should prove valuable; though an exception to his principle is noticeable in the case of ethyl iodide, where improvements on the method given have been available for many years.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 16 ..Architects, Royal Institute of British, 9 Conduit Street, W. 8 p.m. Debate on "Are Building Bye-Laws destructive of Rural Beauty," opened by Mr M. H Baillie-Scott

Asiatic Society, 74 Grosvenor Street, W 1 4.30 p.m. Mr. J. P. Mills, "The Chittagong Hill Tracts"

Electrical Engineers, Institution of, at the Royal Technical College, Glasgow 7.30 p.m. Dr H Norinder, "Surges and Over-Voltage Phenomena on Transmission Lines due to Lightning and Switching Disturbances"

Geographical Society, at the Æolian Hall, New Bond Street, W. 8.30 p.m. Mr. M. A Spender, "Further Work on the Great Barrier Reefs"

Mechanical Engineers, Institution of, Storey's Gate, S.W. 7 p.m. Mr C. G. E Dald, "Calculating Machines."

Swiney Lecture on Geology, at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr Douglas Allan, "Rocks as Records of Earth History. Lecture IV Palæogeography and Earth History"

University of London at King's College, Strand, W.C. 5.30 p.m. Maj.-Gen Sir F Maurice, "The Western Front, 1915 from the Battle of Festubert to the Battle of Loos Lecture II The Battle of Festubert."

At the University College, Gower Street, W.C. 5.30 p.m. Miss E. J Davis, "How London became the Capital" (Lecture V.)

TUESDAY, DECEMBER 17 ..Anthropological Institute, 52 Upper Bedford Place, W.C.1 8.30 p.m. Mr J. P. Mills, "A Tour in the Chittagong Hill Tracts"

Civil Engineers, Institution of, Great George Street, S.W. 6 p.m.

Heating and Ventilating Engineers, Institution of, at Milton Hall, Deansgate, Manchester 7 p.m. Mr F. G. Rathbone, "Economy in Steam Plants"

Statistical Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5.15 p.m. Mr R. G Hawtrey, "Money and Index Numbers"

Transport, Institute of, at the Institute of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Colonel F. Rayner, "The Panama Canal"

University of London, at King's College, Strand, W.C. 5.30 p.m. Prof Sir B. Pares, "Russian History to 1861 Lecture X Russia and Europe: Ukraine"

WEDNESDAY, DECEMBER 18 ..Civil Engineers, Institution of, Great George Street, S.W. 6.30 p.m.

Electrical Engineers, Institution of, at the Royal Victoria Hotel, Sheffield 7.30 p.m. Mr J. F Colquhoun, "Public Street Lighting"

At the Cleveland Technical Institute, Middlesbrough 7 p.m.

Geological Society, Burlington House, W. 5.30 p.m.

Meteorological Society, 49 Cromwell Road, S.W. 5 p.m. (1) Messrs J Edmund Clark and I D Margary, "Floral Isophenes and Isakairs." (2) Sir Gilbert Walker, "On the Mechanism of Tornadoes" (3) Mr E. W Bliss, "A Study of Rainfall in the West Indies."

Microscopical Society, 20 Hanover Square, W. 8 p.m. (1) Mr W. Wall, "A Trifoliate Pedicellaria in Echinus Miliaris" (2) Mr F V. Welch, "A Microscope Lamp" (3) Mr J E Barnard, "Note on Dark Ground Illumination"

Public Health, Royal Institute of Public, 37 Russell Square, W.C. 4 p.m. Prof. Dr E. L Collis, "Industry in Relation to Personal and Public Health."

Sanitary Engineers, Institution of, at Caxton Hall, Westminster, S.W. 7 p.m. Mr H. N. Carvalho, "The Channel Tunnel"

Swiney Lecture on Geology, at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr. Douglas Allan, "Rocks as Records of Earth History. Lecture V -Pre-Cambrian Rocks"

THURSDAY, DECEMBER 19 ..Chemical Society, Burlington House, W. 8 p.m. (1) Messrs A. Smithells and H Whitaker and Miss T. Holmes, "The Influence of Hydrogen and of Water Vapour on the Ignition of Carbon Monoxide" (2) Messrs F H Burstall and S. Sugden, "The Parachor and Chemical Constitution Part XIV Tellurium Compounds" (3) Mr K. A N. Rao, "Studies in 'Strainless' Rings Part II -The Effect of Transdecalin on the Carbon Tetrahedral Angle." (4) Messrs J. N. Ashley and C R Harington, "Synthesis of 1-2-thiol-histidine" (5) Mr F. L Pyman, "2-Thiol-4(5)-β-aminoethyl Glyoxaline (2-thiolhistamine)"

Electrical Engineers, Institution of, Savoy Place, W.C. 6 p.m. (1) Lt.-Col S F Monkhouse and Mr J C Grant, "The Heating of Buildings Electrically by Means of Thermal Storage" (2) Mr T G N Haldane, "The Heat Pump an Economical Method of Producing Low-Grade Heat from Electricity"

At the Municipal College, Portsmouth 7.30 p.m. Mr G Shearing and Captain J W S Dorling, "Naval Wireless Telegraphy Communications"

Linnean Society, Burlington House, W. 5 p.m.

Mechanical Engineers, Institution of, at the Queen's Hotel, Birmingham 6.30 p.m. Mr Ernest Gregory, "Power Transmission Gearing."

At the Hotel Metropole, Leeds 7.30 p.m. Prof G F Charnock, "Bearings for Line-Shafting"

Mining and Metallurgy, Institution of, at Burlington House, W. 5.30 p.m.

Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 8 p.m. Informal Meeting Exhibition of Apparatus Cinematograph Film of the American Petroleum Industry by Mr J. Kewley.

Rubber Technologists, Institute of, at the Manchester Café, Ltd, Exchange Buildings, Manchester Papers on "Reclaimed Rubber"

University of London, at University College, Gower Street, W.C. 5.15 p.m. Prof J F. G de Montmorency, "Momentous Lawsuits and Trials in various Countries from Classical to Modern Times." (Lecture VI.)

At University College, Gower Street, W.C. 5.30 p.m. Dr A M Bassani, "Gaspare Gozzi."

FRIDAY, DECEMBER 20 ..Electrical Development Association, British, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 7.30 p.m. Display of Electrical Cinematograph Films

Empire Society, at the Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Chief Os-Ke-Non-Ton, "The Red Indian in Song and Story"

London Society, at the ROYAL SOCIETY OF ARTS, Adelphi, W.C. 5 p.m. Mr John Walter, "The Times"

Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Mr W. Challis, "Light Signalling on the Southern Railway"

Royal Institution, 21 Albemarle Street, W. 9 p.m. Dr Emile Cammaerts, "Italian and Flemish Art A Contrast"

Swiney Lecture on Geology, at the Royal College of Science (Old Building), South Kensington, S.W. 5.30 p.m. Dr Douglas Allan, "Rocks as Records of Earth History Lecture VI Older Palaeozoic Rocks"

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.2.

NOTICES

DR. MANN JUVENILE LECTURES

Under the Dr. Mann Trust, CAPTAIN C. W. R. KNIGHT, M.C., F.R.P.S., F.Z.S., will give two lectures for children on "The Golden Eagle," and "Wild Life in the Treetops," at 3 o'clock on Monday afternoon, December 30th, and at 3 o'clock on Wednesday afternoon, January 1st. The lectures will be illustrated by cinematograph films. The syllabus of the two lectures is as follows.

LECTURE I (December 30th).—THE GOLDEN EAGLE. Romance of the Highland king of Birds—three eyries. The Adventures of William and his sister. The Crowning Climax. Slow motion film of Golden Eagle's flight. The liberation of Captain Knight's trained Eagle in Sutherlandshire.

LECTURE II (January 1st).—WILD LIFE IN THE TREETOPS. Close hand observations (pictures) of some of Britain's most dramatic birds in their tree-top homes—Herons, Hawks, Owls, Woodpeckers—as shewn in intimate studies. The pictures taken from an observation post on the swaying treetops are of exceptional beauty and thrilling interest.

Special tickets are required for these lectures. A sufficient number to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions each Fellow is entitled to one ticket admitting two children and one adult. Fellows who desire tickets are requested to apply to the Secretary at once.

COUNCIL

A meeting of the Council was held on Monday, December 9th. Present:—Mr. Llewelyn B. Atkinson, M.I.E.E., in the Chair; Captain Sir Arthur Clarke, K.B.E.; Mr. Peter MacIntyre Evans, M.A., LL.D.; Sir Edward Gait, K.C.S.I., C.I.E.; Col. Sir Arthur Holbrook, K.B.E.; Mr. P. Morley Horder, F.S.A.; Major Sir Humphrey Leggett, R.E., D.S.O.; Sir Philip Magnus, Bt.; Sir

Reginald A. Mant, K.C.I.E., C.S.I.; Sir George Marjoribanks, K.C.V.O. Col. Sir Henry McMahon, G.C.M.G., G.C.V.O.; Mr. J. A. Milne, C.B.E.; Sir George Sutton, Bt., and Lt.-Col. Sir A. T. Wilson, K.C.I.E., C.S.I., C.M.G., D.S.O., with Mr. G. K. Menzies, M.A. (Secretary), and Mr. W. Perry, B.A. (Assistant Secretary).

A letter was read from Lord Bledisloe, resigning his seat on the Council on his appointment as Governor-General of New Zealand.

The following candidates were duly elected Fellows of the Society:-

Alexander, Lieut.-Colonel Maurice, C.M.G., K.C., B.C.L., London.
Alexander, Miss Rachel F., London.
Baron, Louis Bernhard, London.
Biltcliffe, Mrs. Lina, Low Fell, Gateshead.
Binning, The Rt. Hon. Lady, London.
Boving, Jens Orten, St. Leonards, Herts.
Carlisle, Hildred, London.
Carpenter, E. H. O., London.
Castlestewart, Countess, Nutley, Sussex.
Cohen, Fred, London.
Eadon, Alan Theodore Eden, Edgware, Middlesex.
Fildes, Frank Cyril, Newcastle-on-Tyne.
Hughes, C. E., Orpington, Kent.
Knight, Arthur Horace, F.A.I., London.
Lee, Lennox Bertram, J.P., London.
Lowis, Mrs. R. F., Binfield, Berks.
Maxwell, Donald, Borstal, Rochester.
Middlecoat, George Keith, London.
Mileham, Harry Robert, Hove, Sussex.
Mills, Arthur Wallis, London.
Moll, Otho Charles Henry Leopold, Gillingham, Kent.
Morison, Bruce, Salisbury, Rhodesia.
Murray, The Hon. Mrs. Graham, London.
Neasham, G. W., Eastbourne.
Perry, William, J.P., Brisbane, Australia.
Piper, Miss Elizabeth, A.R.E., London.
Rigg, Major Richard, O.B.E., T.D., J.P., B.A., London.
Siddle, W., Middleton St. George, Co. Durham.
Spanton, Miss Mabel, B. W. S., London.
Smythe, Richard, Hampton Hill, Middlesex.
Thorowgood, Wilfred E., London.
Tyrwhitt, Walter Spencer Stanhope, B.A., Oxford.
Wethered, Vernon, B.A., London.
Wederkinch, Holger, Charlottenlund, Denmark.
Welsh, William, Harrow, Middlesex.

It was reported that the late Mr. Herbert Louis Leach had bequeathed the sum of £100 to the Society, and it was resolved that this should be used towards the reduction of the debt on the Society's house, which now amounts to about £4,000.

On the recommendation of the Examinations General Purposes Committee it was resolved to hold Course Examinations in 1930 at Kingston, Jamaica. The

arrangements for the Examinations will be in the hands of the Board of Education, Jamaica.

Mr. P. Morley Horder, F.S.A., was appointed as one of the representatives of the Society on the Council for the Preservation of Rural England, in place of the Secretary.

A resolution with regard to the proposed establishment of a National Park in Great Britain was unanimously passed (see below).

A quantity of financial and formal business was transacted.

NATIONAL PARKS

The following resolution was passed by the Council at their meeting on December 9th :—

> The Council of the Royal Society of Arts view with profound satisfaction the progress of the movement for establishing at least one National Park in Great Britain. They understand that the object of a National Park is "to conserve the scenery and the natural and historic objects and the wild life in areas of unusual scenic beauty in the United Kingdom, and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."*
>
> The Council are pleased to remember that the movement was initiated at a meeting of the Society over which Lord Bledisloe (now a Member of the Council) presided.

It was resolved that copies of this resolution should be forwarded to the Committee on National Parks and to the Press.

* This definition is adapted from the wording of the Organic Act of the United States Congress of August 25th, 1916, establishing a National Park Service.

SIXTH ORDINARY MEETING

Wednesday, December 11th, 1929. Mr. John Maughfling, C.A., in the Chair. A paper on "Overheads and other Factors influencing Road Transport Costs, from an Engineer's Viewpoint," was read by Major Charles Wheeler, O.B.E., M.I.A.E., formerly Chief Automobile Engineer of the General Post Office. The paper and discussion will be published in the *Journal* dated December 27th.

HISTORY OF THE ROYAL SOCIETY OF ARTS

Further copies of the History of the Royal Society of Arts by the late Sir Henry Trueman Wood, the existing supply of which was recently exhausted, are now available, and can be obtained, price 15*s*. net, on application to the Secretary. The History, a large octavo volume of 558 pages with a large number of illustrations, gives a well documented account of the many and various activities of the Society from its foundation in 1754 to the year 1880.

PROCEEDINGS OF THE SOCIETY

FIFTH ORDINARY MEETING

WEDNESDAY, DECEMBER 4th, 1929

SIR LAWRENCE WEAVER, K.B.E., in the Chair

THE CHAIRMAN, in introducing the lecturer, said it gave him great pleasure to take the Chair on that occasion, for a variety of reasons; in the first place because he was a great believer in Mr. Harry Peach, who was an old friend of his, and, secondly, because he was an advertising man and felt that the business of advertising was in some sort on its trial, and properly on its trial, in connection with the pollution of the countryside, and, thirdly, because where there was a fight he liked to be in it. The fight on the present occasion was for no less than the preservation of the decencies of England, and he was very glad that such a doughty fighter as Mr. Peach was in it. Mr. Peach recognised the well-known principle of "When you see a head, hit it" A lot of people had said to him that Mr. Peach was an ungentlemanly fellow, because he spoke with undeniable plainness. He thanked God for that.

Mr. Peach had spoken very often and very harshly to him because he had not fought sufficiently hard in some of the good causes in which Mr. Peach had himself been a doughty fighter.

He supposed that most of those present knew of the case of Mr. Plimsoll. Rascally shipowners were sending to their death crews in ships which were overloaded, and it was perfectly well recognised by everybody that if you sent to sea ships thus overloaded, and a serious tempest descended on that ship, the ship would go down, and with it all the people who were working the ship. Ships continued to go to sea in that condition. Mr. Plimsoll was like Mr. Peach an exceedingly ungentlemanly person—and in Parliament and out of Parliament, in season and out of season, he said that this thing was a crime and a scandal, and he so annoyed all the gentlemanly and ladylike people that ultimately he succeeded in getting an Act passed which prevented a ship going to sea if the cargo weighed down the ship below a line painted on the ship. Thus the extremely ungentlemanly Mr. Plimsoll was responsible for a very great reform. He looked upon Mr. Peach as another Mr. Plimsoll.

The following Paper was then read:

THE ADVERTISER AND THE DISFIGUREMENT OF TOWN AND COUNTRYSIDE

By HARRY H. PEACH,

Hon. Secretary, Council for the Preservation of Rural England Exhibition Committee

The disfigurement of town and countryside through advertisement is of comparatively recent growth, especially the latter, which dates mainly from the development of the motor car. It has increased recently with such great rapidity that the question is now forcing itself upon a public which has become very

hardened to its surroundings and has little appreciation for refinements of beauty in landscape or architecture.

The increase of the motor car among all classes has sent them out into the countryside and they have been shocked at the untidy mess made by most garages and offended at the vulgar shouting signs which spring up behind hedges and often invade what the public have been led to recognise as a beauty spot. I propose this evening to deal first with some of the various forms of advertisement on the countryside with criticism of them, and then with the advertiser's refinements of cruelty to the town (for alas no other word expresses it), and some suggestions for the future.

Let us begin with the garage and some examples of the various forms of disfigurement this causes.

This example is on the Yorkshire moors between Scarborough and Whitby, and you will note the unnecessary mess which the various firms' signs have made around a not-too-tidy shed.

The list of signs is as follows :

1 Raleigh, 3 large B.P., 3 Bicycle, Large Pratt, Player's, Benzole, Castrol and other small signs.

Next is one on the Coventry to Dunchurch Road, a beautiful road mentioned in "Tom Brown's Schooldays." The old farmhouse at the Straight Mile corner had its garden wall removed and on the magnificent beech was a Pratt sign. I sent a protest to the Petrol Company and the Pratt was removed to a barn at the side and this took its place. On the other side of the tree is this mess, and it is sad to see our Union Jack prostituted to this unpleasant use. The Government hold shares in this company, and they and the directors ought to know better.

But that is not all. Other trees are disfigured and the 100 yards before arrival are messed up with other signs.

It is not so much the pumps that disfigure the countryside. They are functional things and as such are shaped for a purpose. If painted a green or neutral colour certainly they are better. It is the advertisements around the garage which are really of little or no use. I doubt if anyone in the room can say they have been the least influenced by these blatant signs beyond being annoyed by them. The latest abomination in this way is the R.O.P., a form of Russian propaganda to which the late Home Secretary could really have turned his attention with much more reason than some of his other anti-Russian exploits.

Among other advertisements they persuade the garage owner to paint his roof and cause the mess as now seen too often. One garage owner told me the Warwickshire County Council had made him remove a number of signs. He had a yard full, and yet he was pestered every week by the advertisers trying to persuade him to put up others.

The large advertisers and the agents have a host of men with motors and signs, who go round the country trying to persuade the garage owner, tearoom and other small shopkeepers to let them put up signs. Nothing is paid for these but the

Wolston, Warwickshire. One end of the village Green

Wolston, Warwickshire. The other end of the village green. There are 3 bicycle signs on the cottage and numbers of enamel signs opposite.

Wolston, Warwickshire. Hoarding adjoining village green.

person is told they will bring business. The trouble is that the moment one sign goes up the flock of enamel sign harpies pounce on the site and the end is the mess like the following. I counted 64 in one village apart from paper bills.

The worst disfigurement of the villages are the enamel signs of Lyons' tea, which are found from one end of the country to another, an unpleasant red, dark blue and white sign, sometimes four or more on a shop front.

Next to them is the cigarette— Wills' and Player's being the two most prominent and insistent. Then follow baking powder, cattle cake, polishes, starch, mustard, chocolate, etc.

The land and property owner could do much to help in keeping enamel signs and advertisements from buildings or his land by putting in a clause in agreements as suggested at the Leicester Countryside Conference, a copy of which can be had from the Scapa Society or C.P.R.E.

It is rather sad to think that the worthy heads of many of these firms, who are so interested in welfare and other amenities, cannot realise that this disfigurement of the town and countryside does rather make their other work illogical.

The next form of disfigurement is the hoarding and roadside sign of which the Raleigh sign is a very unpleasant form both in design and colour, and which pops up at you from gardens, orchards, hillsides, etc. No doubt it brings some income to the owner of the land, but yellow is peculiarly unpleasant either by roadside or on buildings.

They have removed some lately in my own district and we all hope more will follow.

The advertiser has a queer outlook, and I should like here to quote from a letter I had in reply to a protest about a hillside sign in Wales:

> "Yes, I do recognise this photograph, it is at Capel Curig and I actually stayed in the cottage shown on my holiday last year. This sign does not in my opinion spoil any view as you will see it has only rough rock and grass, heather and trees behind it. There certainly is some scenery facing it a good way over, viz., a mountain in the distance."

Another advertiser once accused me of taking the bread out of the poor widow's mouth by trying to stop roadside signs. I reminded him, firstly, that his interest in the widow was purely a selfish one, and secondly, that the politician had played on the poor widow string so often that it was really worn through.

The roadside barn is another source of income and here is an example. An American leaflet I had sent me showed a similar one with this comment underneath- -

"Mr. Farmer, is this your barn ?" I am glad to say that, bad as farming is in this country, it is not often the real farmer who allows this sort of thing.

The hotel notices at crossroads and entrances to towns are not much credit to the trade. The entrance to Warwick is an awful mess with these and here are some other signs. Most of us avoid such places as advertise in this way. The Ilkley neighbourhood has a lovely view of the Wharfe spoiled by a terrible Hydro sign.

The brewers have recently taken to blistering the walls of their inns with great

notices of their beer. The good old proverb, "Good wine needs no bush," is either forgotten or perhaps does not apply nowadays.

Some local papers still have a nasty disease called flybilling, that is the indiscriminate placing of bills on fences, hedges, trees, etc. and it is occasionally caught by the billposter. I had occasion to effect a cure locally not long ago when a local paper had an eruption. A little personal persuasion from those in authority will usually stop it, but if you have a litter byelaw you can prosecute under that if the bills lie about. One is glad to see in this respect that the small bills that used to be put on gateposts by flybillers have practically dropped out.

One large firm who stopped it on grounds of decency said that it not only saved them money for decent advertising but that it had been proved useless. I expect a good deal of this country advertisi[illegible] really come under the same category if the truth were known.

Another unpleasant form of disfigurement of the countryside is the railway-side advertisement. Why we should be reminded that we need liver pills every time we travel, I don't know. A facetious friend recently suggested that we might put one of these signs in the delightful village in Derbyshire in front of the advertiser's own house and see how he liked the daily reminder.

The distemper men also cause much bad temper to those travelling.

The "Yorkshire Post" and some other papers are also offenders, and I am sorry to say even the excellent Technical College at Loughborough has a huge hoarding advertising the College in the Soar Valley.

I am informed by the Scapa Society that most of these are coming down under the 1925 Act when the five years exemption is up.

This form of advertisement can be kept down, I believe, easily if the Advertisements Regulation Act were more strictly enforced by County Councils, most of whom have now adopted it.

In its early days it was considerably checked by the application of the Act. Could not the County Councils also enforce the doing away with the great signs showing us that we are arriving at a petrol station or garage and adopt some standard sign like those adopted for schools, etc.? This has been suggested to the A.A., who could really do something in this direction as they also could with tidying up garages if they would take the trouble. They might also make their own signs less aggressive and get them better designed.

By the bye, why do we want those yellow signs at bridges at all? The Leicestershire A.A. recently adopted a resolution only to patronise pleasant petrol stations, and I believe if this were adopted all over the country it would help to clean up garages and petrol stations faster than the new Government regulations.

With regard to the countryside, I have failed after much discussion with advertisers and others to find any solution or suggestion except the total abolition of all advertisement except a decent and orderly treatment for the garage and trade sign to shop and inn, and along with many others I feel that the roadside sign with its bludgeoning, the great notices on bridges, the enamel signs on shops and barns, are a dis-

credit to the manners of the great advertising firms and their agents, and am convinced that before long, unless they realise this and have the decency to remove their disfigurements, it will react on the public, who will, as many already have done, boycott the articles advertised.

Turning to the problem of urban advertising, we have in self protection to become so hardened to its hideousness that I find most people have unconsciously become oblivious to the advertisements which disfigure street and building, except where some new bludgeoning method makes its vulgarity unavoidable. I tested a number of people on a bus by which I travel daily, about the hoardings on a pleasant tree-lined road with about 100 yards of advertisement behind the trees. Before the election an advertisement bearing the legend "See what the Conservatives have done" came in the middle of some vulgar beer notices. Only one person I asked had ever noticed the joke.

There should be legislation to prohibit hoardings on pleasant roads like this. The only justification is that it hides the railway and cemetery where, alas, our trying to shout each other down in life is often repeated, or we should have the quiet local stone and not blatant white marble, a most unsuitable material for our climate. Some say it is a result of the letter and not the spirit of classical education.

One of the most serious menaces to the amenities of our towns, however, is the new form of disfiguring the fronts of buildings with great signs, and the brutality with which the companies offer these sites does not do them much credit.

Here are some examples from a booklet I recently had sent offering me space. The advertising agent calls this form of advertising 'the greatest good." What do you think? This has defaced London in a way most discreditable to the centre of a great Empire, and how the advertiser can reconcile this with his education as a gentleman I fail to conceive. This form is now spreading to the provinces. One of the first in Leicester is next to a new garden near Simon de Montfort's old castle, and the beautiful church where Chaucer was married. A good citizen gave a square opposite, but I hear the Corporation are placing a public convenience in it. The sad story of the little squares in this country may be told here. Here are the entrances to one, here are some of the advertisers' and shopkeepers' embellishments, here are the remains of the Election, in spite of the C.P.R.E. asking every candidate to clear up when he cleared out. Then the Corporation finishes the story with a convenience.

But there is another way of treating a little square. Squares should be for public uses, not public conveniences.

The problem of the shop front and the shop fascia, where each firm tries to shout the other down, is another sad disfigurement to the street and very often to our once pleasant country towns. Have you noticed how many of Newbury's beautiful old houses have been ruined by unsympathetic treatment? Uniformity in lettering on the fascia as in the example here shown helps to make the pleasanter street.

I think we can safely boast that Leicester is the best lettered town in the Kingdom, thanks to our School of Art and the work of one man, Mr. B. J. Fletcher, for many years its headmaster. Had it not been for him and his teaching I doubt if I should have been here with you to-day.

Another serious menace, and perhaps the worst to all architecture, is the enamel sign. I am surprised that architects all over the country have not been up in arms about this and demanded legislation to prevent, along with the former method, the spoiling of the fronts of buildings. What encouragement is there to any man to build decently when his neighbour can be as unneighbourly as this?

The enamel sign commences almost immediately any little shop opens. Cigarettes are usually first, and they have carried their disfigurements to a refinement of brutality not equalled by any other advertiser. The cigarette advertisement disfigures more shops and buildings than probably any other form. It is much worse than petrol.

It requires a curious mentality for the directors of these companies who are causing the terrible defacement of our towns, if they are educated men, to reconcile this with their benefactions in other directions, and yet not see how illogical such an attitude is.

Also, seeing this firm has such a monopoly of the trade, ought they not to set an example, which they would be quite able to do? It is no good, as one so often gets told, "Oh, our advertisement agent or manager does that." The heads of the large concerns who are defiling our towns and countryside are the culprits, or as a writer in one of our leading papers recently called them, they are the "advertising huns" Next after cigarettes, tea, starch, mustard, polishes, soaps and chocolates, are the chief sinners, and one is rather surprised to find here that the enlightened firms who build garden cities are among the disfigurers of our back streets. I wrote to one of these firms who I knew might be sympathetic and received the following reply:

"We sympathise with the objects of the Countryside and Footpaths Preservation Society and have, for many years past, made it a practice to avoid disfiguring beauty spots with enamelled plates or roadside signs.

With regard to advertising on shop fronts, we have cut this practice down to a minimum, but in view of the activities of some of our competitors, we cannot see our way to eliminate this form of advertising altogether. You may rest assured, however, that in no case will our advertisements be fixed in such a manner as would seriously offend the susceptibilities of those who desire to enjoy the beauties of the countryside."

Advertisement is very like armaments, and just as we fear armaments may ultimately ruin our civilisation, so will advertisement, unless very quickly checked, help to ruin our towns and countryside.

I am glad in this connection to say that the Shell-Mex Co., whose signs were one of the worst offenders, decided not to issue any more and are prepared to do their best to get signs removed from garages that caused disfigurement. A number in the Midlands have been removed, but some of the small garage owners refuse

Garage at Theale. The enlightened garage owner, thanks to the encouragement of the Shell Company, taking down enamel [illegible] ning up his [illegible] of England

to take them down on various grounds. They have cancelled 11,000 agreements and removed some thousands of signs. As they are continuing the campaign one can only presume that Shell sales have not suffered.

A friend, recently travelling in America, told me that in a 90 mile run through lovely country he was never once out of sight of advertisements. Now, we are not going to allow that sort of thing, if I know my fellow countrymen aright.

Here is the Billposters' point of view taken from a prominent journal of theirs for November.

> "Bill posting is spreading into all parts of the country. The great increase in the use of the roads means that the advertiser must make an effort to reach the crowds who travel by charabanc and motor-bus. Efforts to stop bill posting in *rural areas* will be just as effective as Knut's command to the waves."

What is your opinion, gentlemen?

I was much amused recently at a circular that came in asking me to advertise on the Nigerian railways. We get accused by our friends abroad of sending missionaries and then guns and whisky to the poor benighted heathen, but we might do better than teach him how to mess up his stations as we have done.

No doubt you all saw the article in the *Morning Post* about advertisements in Lebanon and on the Sphinx.

It amuses me to see worthy people working themselves up over litter and yet they cannot see that we are encouraging everyone to be untidy by the more permanent litter of advertisement we are spreading over our civilisation. In the provinces one suffers much from the temporary bill board which well intentioned societies ask you to place on your garden fence. The roads get lined like this (slide). Now, our friends abroad have largely solved this problem by the kiosk which we might with advantage adopt here.

In Germany these are called Litfass pillars and Berlin has some 3,000 odd of them. They arose from a flybiller putting his bills on pumps at street corners, when he conceived the idea of putting up these pillars. When I get to a German town I always go to a Litfass pillar and there are all the theatre notices, concerts, lectures, political meetings, etc., in a decent and orderly form. The Swiss have the best of these I have come across in Zurich.

The kiosk idea is worth very serious consideration and it might be possible to combine it with a number of our littered small erections, such as telephone boxes, ambulance boxes, rubbish containers, sand bins, many of which are poorly designed. The C.P.R.E. might do well to suggest to its constituent architectural bodies to get out some designs for orderly treatment of them, with distinctive signs for their use.

And speaking of Zurich, here are some more examples of how public opinion has made advertisement into an orderly and quite decent affair.

I daresay some of our outdoor advertisers will not like it, as apparently all the advertising spaces in a town are regulated by the town council and let to one firm, though I believe the individual shop has certain rights, but public opinion in the main keeps these in check. A letter from the director of the Swiss Union of Towns is here interesting.

> "The Swiss towns without exception have made an agreement with the Universal Poster Company, which guarantees to this Company alone the right to put up posters. The conditions of the town administrations, which will interest you, are as follows :-
>
> 1. The town is authorised to demand the removal of hoardings and pillars on aesthetic grounds at its expense.
> 2. The poster company has to erect and maintain the hoardings in an inoffensive way.
>
> Further rules guaranteeing a tasteful arrangement of the posters do not exist. It is consequently solely the merit of the Universal Poster Co. that they set out the posters in the effective and beautiful way which you rightly praise. It is to be noted, above all, that if unpleasant posters were used and posted in ugly ways the public would very soon become openly critical. On these grounds the poster company will take great care to avoid being blamed for bad taste.

The posters at Zurich, in main streets, are 4 ft. by 2 ft. 9 ins. and these are mostly in one row only, though sometimes two rows are allowed. The hoardings are simply framed in and the limit of size of poster gives the artist much better scope than our large bludgeoning posters, which I am told the Americans have now lengthened as cars go so fast that they cannot read upright ones properly, so I

suppose some bright advertiser will lengthen out here soon; in fact I see they are now beginning.

One hoarding on a pleasant square with fine buildings around had granite pillars at each end and a border of flowers underneath. As you would expect, the pretty blue and white trams have no advertisements, nor the orderly tram shelters and station fronts.

Our attempts, and few they are, of orderly advertisement are all far too big, except the example of the Empire Marketing Board. City Corporations might set an example by having similar boards and insisting on each department having standardised notices instead of allowing one to shout the other down like this example, which is typical.

The President of the Poster Advertisers' Association wrote recently to the press saying that Sir Reginald Blomfield had designed a hoarding for them, suggesting therefore that no one could now complain of hoardings. The frame is only part of the job, though it is important as giving orderliness.

They also have pointed out how their hoardings hide tip heaps, etc.

Here is a comment from one of their papers, criticising an article of mine on Zurich, and some examples of what they call orderliness in advertising. The writer goes on :—

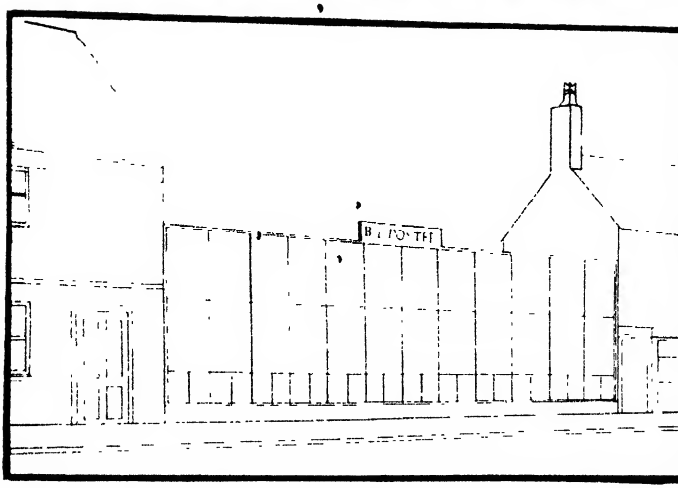
> "These types of hoardings are pleasing and unobjectionable, and I feel sure that to reasonable thinking men they offer a satisfactory answer to the plaints of the antis, who unthinkingly condemn all hoardings because of the few that offend.
>
> I sometimes wonder if those who clamour so loudly for the abolition of the hoardings and outdoor advertising generally, even pause to think what consequences their success would entail, if they realise how many of their fellow countrymen are earning their livelihood from the various trades which the hoarding makes work for, such as the paper maker, the ink manufacturer, the colour men, the printers, artists and designers, bill-posters, etc., not to mention those in the various agencies handling the appropriations, etc.
>
> At a time when every ounce of trade is of value to us, surely it is a disservice to the nation to do anything that tends to hamper its workers in the struggle to keep employed, and it is essential to face the fact that advertising is the very life-blood of business. Those who seek to interfere with its legitimate branches are surely doing their best to fling fathers of families on the unemployed scrap-heap and add a needless burden to the already pressing unemployment problem of the country."

This sort of story we have all heard before, but no man has a right to injure his neighbour by his trade. Has this gentleman ever thought of the many, many firms who supply a great public and never do outdoor advertising ? I have watched the growth of some chocolate firms who never use outdoor advertising. They have, during the last ten years, developed a great shop trade by brains in selling and taste in packing and quality of goods.

The hoarding proprietor must remember he is not the only pebble on the beach.

No one objects to his posting around building operations. It is conceivable that vacant land and certain spaces and bare walls should be allotted in every large town where orderly advertising, with a limit to somewhere near the size of the

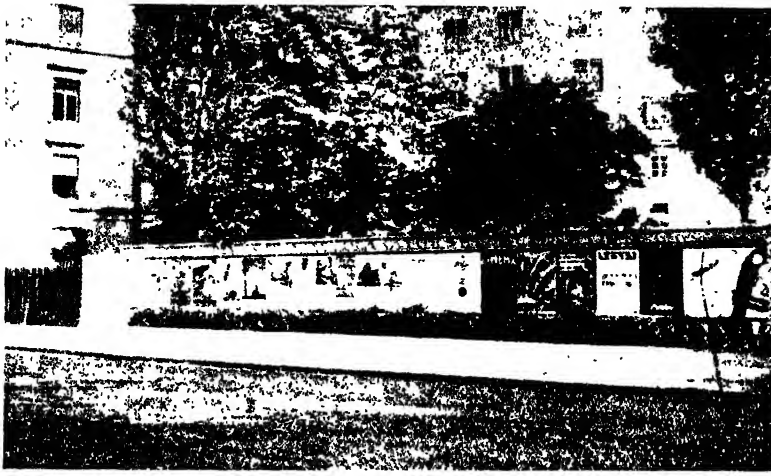
A hoarding on the Main Street, Loughborough.



The Loughborough hoarding set out in an orderly way, reducing size of posters to 60 × 40" with row of auction and public notice bills 30 × 20" beneath.

advertisement as at Zurich, would be regulated in such a way as to be really serviceable to the advertiser and not unpleasant to the general public. He might well shed much of the vulgarity of his posters to the advantage of everyone, but he must be made to leave alone the facades of buildings, with very few exceptions, where an orderly space has been arranged by the architect. Station fronts and bridges must be ruled out, that is, if we are to keep any pride in our cities.

As an example of how some orderliness could be effected I give two sketches of hoardings, first a single row and a double row of 60 x 40 posters with a row of double crown 30 x 20 bills beneath. The first, properly framed in, might be suitable



Typical example of orderly hoarding from Zurich. Public opinion and advertising company's sense of fitness has reduced posters to 30' × 41'

for small country towns on selected bare walls and would be about 8 ft. 6 ins. high, and the second, 14 ft. high, would do for larger towns. Each example is an alternative to an actual hoarding.

This size poster (60 × 40) is quite large enough for any use, and what a difference it would make if our vacant spaces and bare walls were treated in this way. Auction bills, lectures, political meetings, etc., would be standardised to fit into definite spaces or could be half bills, 15 × 20, where less money can be spent. Each advertisement would stand a fair chance of being read and not killed by its neighbours.

I need hardly remind you that we have the Advertisements Regulations Acts of 1907 and 1925 and where these are adopted the County and Urban Councils can remove hoardings that offend the amenities. We owe these to the untiring efforts of one man, Mr. Richardson Evans, who founded the Scapa Society and carried it on with small funds and little support for many years. This Society has not perhaps been as aggressive as it might be, but thanks to its efforts the following have adopted the Acts.

	Number in England and Wales.	Number which have made Byelaws.	Per cent.
Councils of :—			
County Boroughs	83	13	15.6
Municipal Boroughs	255	40	15.7
Urban Districts with population over 10,000..	274	44	16.0
Counties.	62	56	90.3

But, alas, how few exercise them! The Scapa Society has been instrumental in getting them put into force and has removed a number of very aggressive signs in the South, but how few counties are doing their duty to the public.

The last year has shown a marked increase in removals and prosecutions, including Derbyshire, Merioneth, West Riding and Cheshire, all successful, so the future is in the public's own hands.

But public opinion is rising and we get protests from people like the Archbishop of Canterbury, Mr. MacDonald, Mr. Baldwin and others against the atrocities that defile our land. The success of a book like Mr. Williams-Ellis's "England and the Octopus" and the design and Industries Association's Cautionary Guide to St. Alban's, which sold out 5000 copies at once, is a sign of the times. And here can I thank the press generally for the help they have given to the Save the Countryside Exhibitions of the C.P.R.E. which have now visited between sixty and seventy towns, and I hope the Yorkshire press in particular will think better of their enamel sign campaign, which is so increasingly defiling the Yorkshire stone-built villages and moors.

What we really want is more order and gentlemanliness in our civilisation, and let me warn those of you who view with alarm the growing power of the masses that if you teach them disorder and chaos, if you disfigure your civilisation so that they can have no pride in it, what will be the results? You can already see it in the ordinary townsman's treatment of the countryside. The Dean of Manchester referred to this matter in his noble letter to the "Times" just before the last Countryside Conference. "We need something more than law. We need enlightened goodwill and real understanding of the issues involved. We need a wholehearted ambition among our English industrialists to emulate the best European practice and set a lead to tidying up and ennobling industrial surroundings."

Outdoor advertisement is only one way of selling goods and I often feel it is like the wasteful method of Nature where the cod lays two million eggs and two survive. One can hardly call it the maximum result with the minimum of waste.

I doubt if any one would admit that outdoor advertising is other than wasteful. A person posts say 1000 bills in the hope that say 100 of them are in effective positions and the price he pays is adjusted accordingly. If advertising cost a great deal more than it now does, it would be better handled and one remedy is therefore to make advertising dear. The restriction by public opinion and city control in Zurich, I have little doubt, is as much better for the advertiser as it is for the town. One simple course is to tax outdoor advertisement by size. The restriction of size also would demand order to make advertisements more effective.

I never feel that it takes the best type of brains to advertise, and its altruism as talked at advertisers' meetings savours of the Babbit type.

There is too much silly talk about helping British trade abroad as an excuse for home disfigurement, and I do not find firms refusing to advertise American goods or any others who care to pay for them. The advertising has now become a vested

interest, and the main aim, of course, is to advise people to spend money in order that the agent may collect commissions. So long as they collect commission they do not seem to worry about the form and nature of the advertising. It has of course to be effective in some sense so that the person who pays the bills does not realise that 90 per cent. at least of it is waste.

Some of us as business men feel that the outdoor advertising trade really take themselves too seriously as regards the importance of their industry, and we are surprised how slow they have been to learn from such excellent examples as that of the Underground Railway, which is a standard of gentlemanliness, good taste and orderliness in advertising.

The outdoor advertiser has his place but entirely overvalues himself even in our very imperfect civilisation, and when all is said and done the real place for advertisements is the press.

If outdoor advertising can justify its place in this country it must cleanse its own nest, learn more taste, give up bludgeoning and use more brains.

It is comforting however to know that there is an end to all bad things, gentlemen, even enamel signs, and sometimes a real use for them to line cart bottoms. The carter says the bricks slide off beautifully.

DISCUSSION.

MR. FRANK PICK said that he was heartily in support of Mr. Peach and his movement for the control of advertising. There was no doubt that advertising could become a bad habit. Once it had been contracted it spread; it grew upon one, it got worse, and there was no hope unless one was able to inculcate, in the place of bad habits, good habits. From their own experience of bad habits all those present would know how difficult it was to eradicate a bad habit and to create a good one. That was the problem which had to be faced in connection with poster advertising.

In the middle ages the law was framed by the people who suffered from the troubles and injustices of life, and the law was the work of the people. There was a law with regard to nuisance ; if anybody did anything which was a nuisance to his neighbours, his neighbours had a perfect right to abate that nuisance, and so far as offensive smells and offensive noises were concerned the law remained in the same state to-day. If a man was creating a nuisance in these respects, one could stop him and interfere, but we did not seem to have arrived at a position when what offended the eye could be stopped. All that needed to be done was to develop the law of nuisance so that what offended the eye might be abated and removed too. He thought that would be better than regulations and things of that sort.

It would, of course, be of great help in connection with any abatement which might be undertaken if certain forms of advertising were definitely made illegal. The Westchester County of New York, where they were attempting to preserve some of the amenities of that very large metropolis, had certain parkways where nobody might erect an advertisement within a certain distance of the road. That, he thought, was an admirable provision. If anyone erected an advertisement within thirty yards of the road it was an illegal advertisement, and anyone could knock it down who cared to do so. Something of that sort was required in this country.

There was one other recommendation which might come in very handily. The point of view with regard to flyposting was that the person who committed the offence

was the person who fly-posted the bill. The bill-poster could go round the village or the suburb in the early hours and stick the bills on the walls ; the bill-poster then disappeared, and he was the person who committed the offence ; but there was no doubt that the person whose bills appeared ought to be treated as an aider and abettor in the offence, and if anybody whose bill was placed by fly-posting could be fined there would be a cessation of fly-posting. He really thought that a little drastic action should be taken to do away with the tendency for advertising to creep into many places where it was not intended to be.

Mr. Peach had showed a slide of a square in Zurich with a statue of a man and a bull. He did not mention, however, that that statue was put up to the Burgomaster of Zurich, the man who had planned and built the modern town of Zurich in an orderly and proper way. In the Central European countries the Burgomaster corresponded to our Lord Mayor, but he was an official and was paid a salary to manage the town ; he generally did manage the town well, and he saw the results of his own exertions and efforts in the orderliness and decency in which the town developed, and at last he got a statue in the town square. All that orderliness and tidiness to which Mr. Peach had referred was attributable to that Burgomaster whose statue appeared in the public square.

Mr. George T. Mills (President, British Poster Advertising Association) said that neither he nor any of the members of his trade were going to yield to Mr. Peach in appreciation of the beautiful. His Association knew, as a trade, that they had been at fault in the past. It was now some twenty years since they had started to mend their ways. They had mended their ways to a very large degree, and they had done it by self-regulation. He wanted it to be known that the members of the British Poster Advertising Association had not the slightest desire to offend, or to destroy rural amenities. In plain English, it was not good business. If a poster stood where it should not stand, the governing body of the trade did all within its power, irrespective of whether legislation supported them, to have that hoarding removed ; but he must make it clear that although the Association, of which he had the privilege of being President, represented 98 per cent. of the total of the trade in this country ; they did not control the whole.

Another example of how the trade was self-regulating its affairs was that all the members of the London Poster Advertising Association had voluntarily undertaken not to build hoardings on any of the new arterial roads which had been built.

Mr. Peach had made a statement in his Paper which he (the speaker) wanted to nail down very hard. He read an extract from what he had termed a prominent journal of the bill-posters. That statement was unfair, and utterly inaccurate. The journal from which the statement was taken was a house organ, and was owned by a firm of advertising agents which never was associated with the poster advertising industry. The statement he had read was so obviously uninformed that it required no explanation. Mr. Peach himself had contributed an article to that particular newspaper. Need he say more? The British Poster Advertising Association had no control over metal plates, or over any type of painted advertisement in this country. Its business was limited strictly to the showing of posters on hoardings and walls. The slides had shown one or two places where they should not be. He thought Mr. Peach would admit that in no case were those photographs taken less than eighteen months ago, and in all those instances matters had been much improved.

The lecturer had said that the advertiser, when he required an advertisement put up 1,000 posters in the hope that 100 would be seen He had always found that the advertiser was an intelligent being. He would not pay for 1,000 if he were only going to get 100 exhibited.

He felt that the Council for the Preservation of Rural England would be wiser, instead of spreading their attacks as they did, to utilize their energies in forcing the County Councils and other local authorities to adopt the Advertising Regulations Acts. The 1907 Act and the 1925 Act could do all that was required. He thought that Mr. Peach's Society would be well advised to apply its efforts directly to ensure the exercise of those powers which every local authority could have. The Acts he had mentioned, and the Roads Improvement Act and the Town Planning Acts, gave Mr. Peach's Council all the powers they could desire.

Mr. Shaw Desmond said it was necessary to clear one's mind of cant in connection with the question of advertising. He was a novelist by profession, but he was going to take up a strictly business line. In his experience of the United States of America he had travelled in every State in the Union, and he had therefore come into contact with a great many advertisers and a great deal of advertising, and he had had recent experience in Germany, Italy, France, and Scandinavia, and so he felt he had a right to say a few words. At a recent International Congress of advertisers in New York he had spoken on advertising and art. He had asked a man at that Congress to stand up and name at once six advertisements on Broadway. On the spur of the moment he could only remember Wrigley's chewing gum. Going from Broadway to Piccadilly, nothing in the world could prevent the American advertisement from entering this country. One would never get to the basis of advertising until one realised that *les affaires sont les affaires* business is business. He did not believe that anyone would ever be able to check advertising by merely passing virtuous resolutions or by using utopian language. He was utopian, but only in quite an abstract sense. The facts must be faced, and the facts were these. In order to sell goods to-day one had to advertise, and to advertise cumulatively. The cumulative advertisement was the successful advertisement. Mr. Peach would like to relegate advertising to the Press. He had some newspaper shares himself, and he believed that that was the best advertising in the world; but, at the same time, advertising could not be kept to the columns of the newspapers. Writing on the sky had already come, and in Paris the other day he had seen a sky advertisement of the Citroen car That was bound to go on. We were living in an age of democracy, and so far from the age of democracy leading to a beautiful type of advertising, he was quite convinced that it would do nothing of the kind. What it would lead to was a perfect standardisation carried to the nth degree. He thought that tendency was already to be seen.

How was this to be changed? It could not be changed just by Act of Parliament. Acts of Parliament had proved in the past to be dead failures in a thousand directions. It could not be changed by pious generalisation. It could only be changed by that much disused thing—education, by giving the child an idea of the beautiful. That was a very slow way, but it was the only way.

Mrs. B. H. Derry said she had been very interested in the Paper, because the view from her house overlooking the estuary of the Exe had recently been spoilt by an ugly hoarding. She had written to a friend of hers on the local Council, and he had said that the Council had no power to interfere with the man's advertisement, which was on his own property. If anyone was interested she could produce the letter.

Mr. J. H. Wingrave said that if the local Council to which the last speaker had referred had taken advantage of the powers which were in their hands under an Act which was 22 years old, they could immediately have secured the removal of the advertisement which injured the scenery.

MR. N. CARRINGTON said he was tempted to intervene in the debate because he had been associated to a certain extent with Mr. Peach in his campaign, and some statements had been made there which he thought needed a certain amount of illumination. It had been stated quite rightly by Mr. Mills that his Association were in sympathy with the movement, but he sometimes wondered whether there was sufficient co-operation between the Council for the Preservation of Rural England and the Poster Advertising Association. If they got together they could probably do something to remedy abuses without recourse to legislation. He doubted the efficacy of legislation. It was better to educate public opinion. He had asked the Shell-Mex Company in which he held shares to remove objectionable advertisements They had done so, and he thought that shareholders could do a good deal in this way if they took the trouble. It was necessary to convince commercial firms that if they disfigured the roads they would find that they incurred prejudice instead of increasing their sales. That, to his mind, was the only possible remedy, and one that should be pursued with unflinching courage.

MR. H. G. GRIFFIN (Secretary, C.P.R.E.) said that his Council numbered amongst its constituent bodies many local authorities, and they were becoming very much alive to their responsibilities. The Surrey County Council had appointed a committee to deal with the question of advertising, and that committee had come to the conclusion that in certain areas the Acts required tightening up. As soon as this was done it would be seen that the local authorities would take very definite action. The Merioneth and Derby County Councils had already had successful prosecutions.

MR. A. E. GOODWIN (Director of the Federation of Master Printers) supported the remarks of Mr Mills in expressing sympathy with the genuine desires of the Scapa Society or the Design and Industries Association to protect the amenities of the countryside. He felt that a good deal of care should be taken before any further legislative proposals were put forward. No purpose was served by indiscriminate opposition to outdoor advertising. Billposters and printers knew that the whole success of advertising by posters depended largely on the sympathy of the public, and in the opinion of those capable of judging, considerable improvement in the art of poster advertising had been made in recent years

MR. ALFRED C. BOSSOM, F.R.I.B.A., said that ugly advertising had an effect on unemployment in England. About £5,000,000 was spent in England last year by American visitors, as against a sum of between £50,000,000 and £80,000,000 spent by American visitors to France, and it was only by maintaining a beautiful countryside that we could expect to attract Americans to come here and spend their money. He preferred consultation between the various interests concerned, both for and against, to the passing of further legislation.

MISS HELEN WARD expressed the hope that the British Poster Advertising Association would endeavour to follow the example of the Underground Railways, which had acquired a positive reputation not only for unobjectionable but for really beautiful advertisements of a moderate size.

MR. EDWARD WARREN, F.R.I.B.A., said he had long advocated in this country, without success, the imposition of a stamp tax on advertisements similar to that obtaining in certain European countries. This would not only be of considerable help to the Revenue, but would tend to decrease the size of advertisements, for the stamp tax was graduated in accordance with the size of the advertisement. As a

member of the Automobile Association he had written to that Association protesting against their ugly black letters on a brilliant yellow background. These were quite invisible at night, and the ugly colours were therefore not justified on safety-first principles.

MR. A. HANNAY (Chairman, Advertising Section, London Chamber of Commerce) said he had feared that the meeting would not end without a suggestion of further taxation. He did not understand why it was that, if poster advertising was so unpopular, the county counils and other local authorities had not exercised the powers of restraint vested in them by Act of Parliament. It probably meant that some people who were in advance of public sentiment were trying to impose their ideas on others. He thought a broader view should be taken, and as a user of poster advertising he did not apologise, because he had tried to comply with what he believed to be the public taste and sentiments of the day.

MR. SYDNEY WALTON, C.B.E., said he was with Mr. Peach entirely in his desire to preserve the beauty of England. He had been most courageous in his lecture.

Mr. Walton expressed the hope that there would be conference between the British Poster Advertising Association and Mr. Peach's society.

THE CHAIRMAN, in moving a vote of thanks to the author, congratulated him on his courage and all the speakers on the admirable good temper they had displayed towards Mr. Peach in discussing a rather controversial subject.

As he understood it, no one present had any quarrel with advertising, even outdoor advertising, so long as it was decent. He understood from the lecturer that he was entirely in favour of outdoor advertising so long as it did not conflict with the major interests of the beauty of the countryside and the orderliness and decency of the towns.

He was satisfied that the enamel sign was the worst offender, and not the more or less orderly assemblage of posters on a hoarding. Unfortunately there was no association of enamel sign planters -a sort of scandalous trade that dared not put up its head in the daylight. The British Poster Advertising Association and its London society were bodies of highly respectable and responsible citizens who had held out the hand of friendship to the stalwarts of the C.P.R.E. movement, and had expressed their willingness to discuss the matter and to receive specific recommendations as to the removal of offensive posters. That was a great step forward. He did not think there was need to be unduly pessimistic. Mr. Shaw Desmond was very pessimistic, but then, Mr. Shaw Desmond was so eloquent that he would make one believe anything. The public was to be blamed for not sufficiently controlling its local authorities, and making them remove the more intolerable offences. He thought the Poster Advertising Association was quite willing to control their own unruly members if it was suggested to them in a reasonable way ; but it was for the county councils to go after the road signs and the enamel signs, and when that had been done it would be time enough to go after the poster people, some of whom were not as noble as they might be, as Mr. Mills well knew.

He thought Mr. Bossom's suggestion was a very sound and economic one. If the countryside was polluted much more than it was at present, this country would suffer grave economic injury, because there was no doubt that American visitors were increasingly upset at the vulgarisation of the beauty spots they went to see.

The vote of thanks was carried unanimously.

MR. PEACH, in reply, thanked the meeting for their kind reception of his lecture.

EXHIBITIONS OF APPLIED ART

COOLINGS' GALLERY, BOND STREET. BROOK STREET GALLERY, BROOK STREET. The London Artists' Association are showing Christmas presents at their headquarters, Messrs. Coolings'. The senior members proved in Omega Workshop days that they could apply their talents most agreeably to decorative work of all kinds, and their hands have since then gained in cunning. The younger members are sometimes nearly as assured, in their touch, as their elders are. The lampshades shown are attractive, and not expensive; the trays will delight those who care for this sort of thing—and a good honest sort of thing it is. The Duncan Grant chair which lords it over all the smaller fry is gorgeous. There are painted tiles, and boxes, and cushions; the cushion by Douglas Davidson is charming.

Mr. and Mrs. Powell are exhibiting painted pottery at the Brook Street Gallery. When they follow in William Morris's footsteps their patterns are excellent; their rather more representational designs are not, perhaps, quite stylised enough. The shape and quality of their wares are, however, uniformly good, and many a useful present could be chosen from among the coffee sets, ink-stands, mugs and jugs that they offer.

NOTES ON BOOKS

REPORTS ON THE PROGRESS OF APPLIED CHEMISTRY. Vol. XIII—1928. London Society of Chemical Industry. 12*s*. 6*d*. to Non-Members; 7*s* 6*d*. to Members.

The year 1928 was not marked, in most of the industries under review, by any outstanding instances of progress on the technical side. The general level of prosperity, however, was encouraging, and there were many signs that the chief chemical industries of the country were feeling their way back to better times. The first annual meeting of the great combination known as Imperial Chemical Industries, Ltd., was held during the year, and the report presented showed that the profits actually made had exceeded the figures previously estimated. Similar prosperity attended chemical industry abroad, notably in France, Germany and the United States.

In the absence of any very spectacular advances, some points of general interest may be extracted from the Reports. In the gas industry, much attention was directed to the proposal to establish "gas grids" supplying gas at high pressure to whole regions, rather on the lines of the electrical systems now under construction in this country. The scheme was furthest advanced in the Ruhr district; but it is interesting to note that the considerations which make such a system of long-distance gas transmission desirable in Germany are not felt to apply with anything like the same force to many of the large centres of population in Great Britain.

Improvements in methods of domestic heating received a good deal of attention during the year, the main advances being in America, where the use of thermostatically regulated boilers, fired by oil or gas, increases rapidly. The cause of smoke abatement in this country was advanced by an important inquiry held at Bradford, by the Ministry of Health, into the form of a model by-law defining the permissible limits of smoke emitted by factory chimneys. Investigations were also carried on, mainly at Leeds, into carbon monoxide pollution of the atmosphere. This is apparently negligible at present in the open air, even in great cities; but the work emphasized once again the necessity of the use of a flue with gas fires.

Low-temperature carbonisation continued to command public interest, and considerable activity occurred in the erection of plants in various situations—at collieries, gas-works and elsewhere. What was originally the primary aim—the production of smokeless fuel—is now to a great extent over-shadowed by a secondary objective, namely the profitable disposal of fine coal, which otherwise is something of a drug in the market.

The heavy production of mineral oil has of recent years created difficulties for those developing processes of coal treatment, and the imposition by the British Government of an import duty on motor spirit was no doubt gratefully received in such quarters. The investigation of methods for producing liquid fuel by the hydrogenation of coal naturally felt an immediate stimulus, and some progress was made towards a satisfactory solution of the problem. Perhaps the most marked advances in relation to liquid fuels, however, were those associated with the use of lead tetraethyl as an " anti-knock " for internal combustion engines.

The steel industry had no great improvements to record, though much useful work was done, notably in the examination of problems related to corrosion—a subject which was prominent in non-ferrous metallurgy also. In glass technology, the chief advances concerned ultra-violet transmission and non-splintering properties. Rubber, from the economic point of view, suffered an experience the reverse of that of fuel-oil ; for the termination of the Stevenson restrictions tended to terminate also efforts to produce a satisfactory rubber-substitute. The production of artificial nitrogenous fertilisers showed further marked expansion, somewhat opposed in the United Kingdom, however, by the prevailing agricultural depression.

The beet-sugar output underwent a set-back in this country, probably owing to accidental conditions affecting the previous year's operations ; but one new factory was opened, and some progress was made towards solving the problem of utilising factories during the off-season. The world-production of cane sugar set up a new record in the history of the industry, the increase being mainly due to rapid advances made by Java, where a new cane was widely cultivated.

The volume, as in other years, presents an immense collection of material in the most convenient possible form, and both the editor and his contributors deserve the thanks of the chemical industry for the efficiency with which the various aspects of its progress are recorded.

GENERAL NOTE

INTERNATIONAL CONGRESS OF MINES, METALLURGY AND APPLIED GEOLOGY.—The Sixth meeting of the Congress, which will be held under the patronage of H.M. King Albert and organised by the Association of Engineers of the School of Liége, will take place from the 22nd to 28th June, 1930. in connection with the International Exhibition to be held at Liége. Further information in regard to the Congress may be obtained on application to the Secrétaire Général, L'Association des Ingénieurs de l'Ecole de Liége, 16 Quai des Etats-Unis, Liége.

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

FRIDAY, DECEMBER 27..Empire Society, Hotel Victoria, Northumberland Avenue, W.C. 3 p.m. Rear-Admiral Gordon Campbell, "My Mystery Ships."

SATURDAY, DECEMBER 28. Royal Institution, at the Institution of Electrical Engineers, Savoy Place, W.C. 3 p.m. Mr. S. R. K. Glanville, "How Things were done in Ancient Egypt. Lecture I. The Elementary Use of Nature." (Juvenile Lecture.)

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All communications for the Society should be addressed to the Secretary, Adelphi, W.C.2.

NOTICES

WEST WYCOMBE

At the last meeting of the Executive Committee of the Fund for the Preservation of Ancient Cottages, it was considered advisable, in view of the large number of Christmas appeals, to defer a general issue of the Appeal for the West Wycombe Preservation Fund until the spring. The Secretary, however, will be glad to forward copies of the booklet to Fellows of the Society who are interested in the movement.

After Christmas restorative work in the village will have started, and, thanks to the generosity of Lady Binning, who takes a keen interest in this experiment in educative control, the Society will have a building in the village where all information as to the work and its financial requirements can be obtained. This interesting little house is to be equipped and furnished in character with the ideals of the Society.

The Local Authorities have now agreed to bring the necessary services and the drains through the village, and this will enable the Society to sign an agreement with the Trustees of the Douglas Haig Memorial Homes for the restoration of a considerable block of derelict cottages at one end of the village. Negotiations are proceeding with the Staines Brewery in connection with the hotels and inns, with a view to their reconditioning. The Society's Agent is also dealing with the two chair factories, which are two very living assets in the village.

WILLIAM SHENSTONE'S HOUSE, THE LEASOWES

The plea which was put forward at a recent meeting of the Society for this interesting eighteenth century house has received authoritative support Apart

from the correspondence that has been going on in Birmingham in this connection, important contributions have appeared in the November number of *Blackwood's* from Mr. Charles Whibley, from Mr. J. B. Firth in the *Daily Telegraph* on December 9th, and from Mr. Christopher Hussey, entitled "Company at The Leasowes," in *Country Life*. We quote from the last mentioned:—"Yet the City of Birmingham, proud of the cataracts of ugliness that have flowed over the world from its factories, still ignores the meadows on its fringe where the seeds of so much beauty were also raised. For the cost of a few tramcars the little property could be bought, its woodlands be opened as a public park, and belated gratitude paid to a son of Birmingham who gave his countrymen eyes with which to see the loveliness of the world around them—such, indeed, as remain."

OUTDOOR ADVERTISING

Mr. H. H. Peach's paper, published in the *Journal* last week, has attracted considerable notice in the general press. How long are our towns and villages to suffer from the garish untidiness of modern advertising? Mr. Peach has done more than anyone else to draw attention to the growing evil. Why should a decent architectural building be at the mercy of the advertiser? Mr. Frank Pick, who spoke at the meeting, has shown how advertising can be an art when it is under proper control.

PROCEEDINGS OF THE SOCIETY

SIXTH ORDINARY MEETING

WEDNESDAY, DECEMBER 11TH, 1929

MR. JOHN MAUGHFLING, C.A., in the Chair

THE CHAIRMAN, in introducing the lecturer, said that Major Wheeler had spent a great many years in the service of the General Post Office. He was responsible for the introduction in the G.P.O. services of the first bicycle and the first motor vehicle. He was technically responsible for building up perhaps the largest fleet of vehicles in the country. When he retired, the service comprised 20,000 bicycles and 3,000 motor vehicles. Outside his official work, Major Wheeler had always taken great interest in the technical and commercial side of the motor industry and motor transport. He was for six years a Vice-President of the Institution of Automobile Engineers, and he also did good work in bringing to a conclusion the Report on Automobile Nomenclature for the British Engineering Standards Association. His premature retirement, due to ill-health, was particularly hard on a man like Major Wheeler, who was so keenly interested in his job.

The following paper was then read:—

OVERHEADS AND OTHER FACTORS INFLUENCING ROAD TRANSPORT COSTS

By Major C. Wheeler, O.B.E. (Mil.), M.I.A.E.,

Late Chief Automobile Engineer, General Post Office.

"Everything can always be done better than it is being done." *Henry Ford.*

It is customary when reading a Paper before such a Society as this for the author to be more or less an authority on his subject, and whilst I cannot claim special distinction as an accounting expert, nevertheless I believe I have a certain measure of practical knowledge which warrants my bringing the subject under review. Whenever I quote, as often I do, from some other writer, it is not for dearth of opinion of my own, but rather that my belief may be fortified by opinions which have already been accepted as authoritative.

Some folk have had the experience, fortunate or otherwise, at one time or another of being associated with an undertaking, in connection with which a Committee of dissatisfied shareholders has been appointed to inquire into "who, the why, the what."

It is probably within the memory of many that as recently as 1922 the Board of Directors of the British Empire, under the pressure of shareholders' opinion, appointed such a Committee of Inquiry, to investigate the expenditure of various Government Departments, which Inquisition, popularly known as the "Geddes Axe Committee," in due course made a searching exploration of the costing system of the Transport Section, managed by myself, and commercial magnates of the calibre of Sir Eric Geddes and Sir George Beharrel reported that "having examined the checks employed on the running of these vehicles, we find that adequate allowance is made for depreciation, interest on capital and other overhead charges . . . has effected substantial economies, etc."

I am inclined to the view that the progenitors of the original Post Office were intimately connected with one of the Lost Tribes of Isreal, if indeed they were not the real McKay, so deeply ingrained in the constitution of the present-day organisation is the fetish "vill it pay?" Strong financial justification has to be made with every fresh field of operation in motor transport mooted.

It will thus be seen that in building up and organising the largest fleet of stores vans in the country, running some twenty-five million road miles per annum, and under the conditions already remarked, I have graduated in an economic school second only in status to Aberdeen.

The phenomenon of a State Department being able to run a motor transport service with profitable results is not without interest at a moment when the question of unification of control of London transport under State authority

looms so much in the public eye, especially when it is remembered that the responsible engineering personnel had no attraction in the shape of stimulating bonuses and commissions, which give colour to commercial life.

In considering the question of Overheads the subject resolves itself broadly into two groups :—

I. those items over which we have little or no control.

II. those items which will repay one if given consideration or thought, but which rarely receive such purely from the economic point of view, as, for example, administration or management.

The subject being a very wide one, and impossible to cover adequately in a single paper, I have necessarily limited myself to dealing with a few of its aspects from an engineer's viewpoint.

When I settled upon the subject of "Overheads" for my Paper and added the term "and other factors, etc.," I did not envisage the encyclopaedic nature of the complement until I had roughed out a draft exploring the main sections, which preluded voyages of an intricate sequence. The ramifications seemed to be as heterogeneous as the contents of the witches' cauldron in Macbeth. One of the chief difficulties was the selection of factors for discussion. A criterion had to be established, as it was obviously impossible, while confining the Paper to convenient limits, to include everything that would be of interest to all, and yet that which might appear most desirable to some, might be esteemed valueless by others. Eventually, as the result of much cogitation, I decided to cut the Gordian knot by boldly wielding the sword of my own fancy—only that which seemed of special interest to myself should be included ; the method adopted of discussing the various factors is selective rather than comprehensive.

Many of the views put forward may probably have been expressed before, but reaffirmation often serves a useful purpose.

Support for ventilating the question might be urged by virtue of the fact that so many politico-industrial magnates are still insensible of the fundamental verity that almost every transaction in trade involves the movement of goods, and this ignorance, mark you, is in a country in which trade and carrying have been its main pillars of commercial prosperity.

The road transport operator has two distinct classes of work under his control : (1) passenger, and (2) stores, goods, merchandise, luggage, parcels, or freight, to which it is proposed to give the comprehensive title of "stores." Passenger work has certain difficulties peculiar to itself, but as I have had no special experience of this class of work, I will confine my remarks to the transport of stores. The work of transporting stores has three main divisions, namely : charging, transmitting, discharging. It will at once be seen that the Stores Operator, compared with the Passenger Operator, has two extra divisions, as the living freight does its own charging and discharging, the passengers providing gratis the energy to carry out the work.

Industry is not unlike a table with four legs: ***labour***, ***capital***, ***invention*** and ***management*** — each leg contributing towards the stability of the table top, "Industry." If any one leg be weak or missing, so will the top suffer in proportion. No significance must be attached to the order in which the four legs are named; one may commence at any corner of the table—they are all essential components if stability and usefulness are desired, though two of them (***invention*** and ***management***) have not hitherto had that measure of consideration their importance warrants.

Whether a man works with his hands or his brain, if he produces or causes to be produced more than his essential needs the excess is wealth convertible into capital.

I am just a little tired of hearing about the iniquities, rights and dignity of two of the aforementioned table legs, *capital* and *labour*. How about the other two? Strictly speaking, perhaps *Invention* and *Management* should be grouped under *Labour*, but as the latter has become so generally associated with the manual worker only, it is as well to throw a little light upon the other two important supports of Industry.

Back of the motors humming,
Back of the belts that sing,
Back of the hammers drumming,
Back of the cranes that swing,

There is an eye which scans them,
Watching through stress and strain,
There is the Mind which plans them,
Back of the Brawn, the Brain.

Berton Braley.

To vary the simile and to make it more apposite to this gathering, we might say: Industry is like an automobile, with the four road wheels—each of which must do its share in supporting the structure—represented by capital and labour, invention and management; the two former fitted on the rear axle, composing the driving constituent, and the two latter fitted on the front axle, forming the steering couple; in the front wheels we find, or ought to find, as important spokes, science, gumption and wise judgment. In the driving wheels essential spokes are spontaneity, proficiency or skill, resolution or energy.

If the metaphor be accepted in the above form, it will readily be seen that, as is actually the case, capital and labour, invention and management, are necessarily close allies, and the claim of labour to the full result of production, which is rendered possible only by the joint effort of all, is quite unjustified, and there is but little doubt that extravagant claims, by other of the factors, are similarly unwarranted. But let us direct attention upon Management, not however at the moment. It was the spoor of the game I was hoping to track, but my observations upon Scientific Management have, among other matters, had to be jettisoned, for want of time and space.

COST ACCOUNTING.

If accurate costing be important to an undertaking running a number of vehicles, it is doubly important to the One-Man or One-Truck Concern, as, if the latter unknowingly be working at a loss, it results in his quickly going under, whereas there is the possibility in the larger Concern of making on the swings what it loses on the roundabouts.

While the claim is not made that a costing-system will save one from failure, it is urged that a man who knows where he stands day by day is very much less likely to make a failure of his business than one directing his concern by guess-work. Upon my observing to a friend that many post-war owner-driver war lorries were run at uneconomical rates, due to ignorance of such a thing as "overheads," my friend replied, "Well! where ignorance is bliss." But to this I must take rigorous exception; as a fact I know of one case only in which "ignorance was bliss," and that was when a girl was very anxious to have the number 27 allotted to her in a sweepstake. This turning out to be the winning number, her friends naturally inquired why she thought it would win the first prize; she explained that she had dreamt of the number 7 three nights running and that three times 7 being 27 she thought that number was sure to win.

To urge the advantages of good cost accounting in an assembly of this character would be a work of supererogation, but it may not be without profit to ask and try to answer the question: Why a costing system?

In some businesses a costing system is desired in order that the selling price of the commodity may be determined, or, alternatively, a price having already been fixed, to ascertain the cost, to enable an improved organisation to effect a reduction in the price.

It is highly probable that when costing systems were first introduced into business their object was to enable the producer to fix his price, based on the ascertained cost of production (as opposed to the wicked old method of fixing a price at whatever "the consumer or user would stand"), but the *raison d'etre* of a costing system has long since passed beyond this point. Costing knowledge is increasingly necessary now that the margin between production costs and realised prices is so much finer than hitherto.

Since a motor transport business is run for less than alternative service it follows that saving or profit is dependent on the knowledge of cost but, *worse* than no figures at all, are incorrect ones, for without knowledge of costs, ordinary caution would enforce a conservative attitude.

Now, what is cost accounting?

The answer would appear to be this: Cost accounting as practised nowadays is a systematic method of computing expenditure right on the heels of the causative agents which originate the expense, each factor of work and its influence being segregated and scientifically analysed to its exhaustive serviceable point.

The individual or concern that regards accounting as merely a recording function is blind to one of its most salient properties, for it actually provides the Operating Manager with a priceless tool for *control* of his affairs.

While the practical benefits are probably obvious to all, it may not be considered presumptuous to point out that there is an ethical side to the case, which, whilst not so apparent, is nevertheless of appreciable importance, for, by eliminating guesswork in tendering, and substituting accurate estimates, a Business Head is able not only to " play fair " with his competitors and his creditors, but also to give a " square deal," if so disposed, to his " co-partners " (*i.e.*, his employees) in production. For, as the great Bacon observed, "A man is but what he knoweth."

Whilst accounting is fundamentally associated with recording the history of transactions, it will have been compiled, if carried out in an efficient manner, in such a convenient way as to furnish the basis for constructing much else therefrom.

Heed should be given to one most important point, namely, that the labour involved in allocating expense in any system is not too costly. That is a circumstance which the Head of the Concern must himself determine, or depute an assistant, possessed of an efficient logical equipment, to watch carefully.

Incidentally, and purely as a matter of interest and, it is hoped, excusable self-conceit, the fact might be mentioned that the costing system as devised for a dozen automobiles, which I briefly outlined in 1909,* has been appropriately expanded and adapted, and now does duty for many times that number of vehicles.

It may also be of interest to those engaged in ancillary transportation if I explain the method of ascertaining the savings effected by the fleet of Stores vehicles over which I had control. There are certain men in the Stores Depot, under the control of another entirely independent officer, whose special duty it is to determine the most economical form of transport for all consignments being despatched and to co-ordinate demands upon the fleet. These men are expert on all questions of freight, whether railway, canal, hired transport, or depot transport. They are in no way interested with the development of the official Motor Service, being concerned only with the economical and expeditious despatch of stores. They have absolutely nothing to do with costs or maintenance of vehicles, except to be informed of the " all-in " costs of certain types of official vehicles.

For a period of one month per annum these men are asked to keep a careful record of all consignments sent by official vehicles, and to cost them at the ***cheapest alternative means***, whether rail, sea, canal, or hired motors. This cost is multiplied by twelve, and then compared with the " all-in " cost of the official fleet for a year. Obviously it would not do to multiply by twelve the " all-in " cost of the official fleet for the corresponding month, otherwise one might be open to the charge of postponing heavy repairs with a view to reducing costs and thus securing a favourable, but unfair, comparison.

To resume, any system adopted must not be so complicated that several highly-paid clerks are required to operate it. In other words, the organisation must not be " top-heavy." An important factor in its successful operation is the disposition of the clerks engaged thereon ; no effort should be spared to ensure that cheerful support and full understanding of its working is secured from the operator's point

* Proc. I.A.E. Vol. 4. pp. 266, *et seq.*

of view; it pays to show each new employee something beyond the mere routine working of his or her particular patch, otherwise after the moving spirit of the Installer has departed to fresh pastures, the system, however good in its inception, may languish and finally succumb.

I hold a somewhat unorthodox opinion on the injunction for punctilious accuracy in our everyday life, and as an expression of this view has occasionally shocked my accounting friends, perhaps a few moments consideration of the subject may be profitable, especially seeing that the general tenor of this Paper is to emphasise the necessity for ascertaining true facts as the *modus operandi* for securing economy in transport costs.

We are told in the Holy Writ: "To everything there is a season and a time to every purpose . . . . a time to weep, and a time to laugh"; with all due reverence, I would add: There is a time for *absolute accuracy*, and a time for mere approximation; and in support of the latter tenet I submit for consideration two concrete illustrations, wherein pedantic accuracy is farcical.

I remember well in my early days—my very early days, for, like Mark Twain, I was born young—how much I was impressed by the fact that Mount Everest was 29,002 feet high. The unit feet has remained fixed in my memory to this day.

To come nearer home. In a certain newspaper recently the horsepower of an aero-engine was given as 627.5. One does not need to be an automobile engineer to appreciate that in ascertaining the indicated horse-power of an engine—even if carried out by a demonstrator at the National Physical Laboratory—there may inevitably be a small margin of error, one way or the other, in the calculation and measurements. If this error is, say, only 3 per cent., then it would not be incorrect to say that the horse power of the aero-engine in question was either 600 or 650. By stating the horse-power as 627.5, the impression is given that the figures have an exact meaning, which is, of course, contrary to fact. Similarly, the "measuring Johnny" of Mount Everest might have left out the extra two feet without giving offence to the Fellows of the Royal Geographical Society. This class of error is not confined to newspaper articles, but persons who should know better have been guilty of similar dope in technical journals. It was my good fortune some thirty years since to attend a series of lectures by Professor Perry on "Practical Mathematics," and probably some will detect the influence in the examples quoted.

It will be observed that in drafting the Main Expense Schedule I had in mind the I.C. engine only, and that whilst the majority of the items are applicable to steam and electric vehicles, it may be necessary in the case of such types to add items peculiar to them, *e.g.*, water and accumulators, respectively.

A Transport Superintendent is a queer conglomeration; in addition to the actual administration of the technical side of his business he is obliged to keep pace with the rapid progress of Science in Industry, to be an amalgam of engineer, chemist, lawyer, cost-accountant and psychologist, learning to take labour by the hand and not by the throat; he must have a working knowledge of all the

great provinces of transport thus far explored, original competence in some of the main fields, and the capacity to co-ordinate the laws of the whole in a reasoned scheme ; and as a buyer to purchase one thing only—miles—not fuel or tyres—but tyre-miles and m.p.g., and withal, he must be an incorrigible optimist.

Transport organisations vary so much, not only in the character of their work, but also in regard to topographical conditions, that, without a complete grasp or understanding of these variable factors, the mere presentation of cost figures has but a limited value. Even in the same class of business, say the carrying of mails, extreme care has to be exercised when attempting to make comparisons.

Maintenance costs of identical vehicles continuously running on cobbled roads *v.* good macadamised roads ; hilly country, like Amersham and Chesham *v.* a flat district like Bedford ; or, again, if operated in a sparsely-populated quarter as against a district with numerous traffic stops, and so on. Many other indeterminable factors could be mentioned, each of which, in varying degrees, strongly influences the operating costs, but cannot be brought to account by figures. One other important feature, liable to be overlooked, is the percentage of day to night running, and yet another variable in some organisations, the number of drivers per van.

It is for such reasons that comparisons between one organisation and another particular organisation carry little weight. But that does not mean that no use can be made of somebody else's figures. It is useful to compare average figures of the whole concern with average figures of several other concerns, if the latter be grouped together. Comparisons often reveal where leakages are occurring and investigation of the significant items is then called for.

The system upon which I worked was this : The recorded costs of any one vehicle were always compared with the *average* of all vehicles of that particular type, and when a marked difference one way or the other was disclosed, the matter called for investigation, and then were usually brought to light certain adverse or favourable factors of the character referred to. Now the point it is desired to drive home is this : If striking variables exist in your own organisation, how is it possible to determine with a real degree of usefulness how your figures compare with another's ?

Where cost comparison can repay one handsomely is in this respect, and it was a feature of my late business (not the Mail side, but ordinary Stores transport comparable with other Stores transport services).

The possibility of a cheaper alternative is considered in each case before a consignment is sent by Departmental Van and, further, a comparison is made at certain intervals between the cost of the vans and the cost of performing by the cheapest available means all the services performed by the vans during one month as already explained.

To sum up the question of comparing cost schedules, I might mention that I prepared, some few years since, to act as a guide, a large and complete schedule, showing running costs and standing charges for various types of vehicles, but the Schedule bore this significant remark in leaded type : " Whilst the table gives

figures, the result of many years' investigation of the problems, as the recorded costs of many million miles' work, yet, taken singly and applied without full knowledge or due recognition of individual conditions, such facts and figures, accurate in themselves, are liable to mislead."

While it is true that the characteristics of transport organisations differ very much both as regards the varying nature of the work and in respect of their constitution, the necessity for including a complete schedule of overheads in a costing system must be accepted as an axiom in any transport undertaking, no matter of what magnitude. Size is largely a matter of the multiplication table. It is also probably axiomatic to state that when a Transport Controller sits down to examine his records the outstanding feature in his mind is: how do the expenses compare with business done? I do not claim to have made any discovery in the tabulated statement submitted, but believe that a correlation in the form of a Table of *all* the components in a complete costing system will be of service, if only for purposes of reference; it is tendered more in the nature of a blue print than an oil painting.

It must not of course be forgotten that the human element plays no inconsiderable part in any organisation, and bearing this in mind the system should be so devised that it does not depend solely upon any one individual for its smooth running. Always remember the cemetery holds many men who thought their business concerns could not get along without them.

Expenditure may be broadly grouped under Running Costs, Standing Charges, and Overhead Expenses, and whilst it is possible opinion may differ as to whether such and such an item should not come under the Charge Column instead of the Expense Column, it is submitted the point is not of material consequence, the transcendent factor being its appearance *somewhere*.

Having indicated the primary object of drafting the Main Expense Schedule, I will endeavour in the space at my disposal to suggest a few significant features which influence the magnitude of some of the components, and trust that the discussion will bring out certain aspects of the question entirely omitted or too briefly touched upon.

It may be desirable at the outset to indicate what we mean by economy. I remember an observation made many years since by Henry Ford in the pages of the *Dearborn Independent* on the subject of economy, mainly, if memory can be trusted, concerning government. I have forgotten the actual words, but the tenor of his remarks was: "Economy has frequently little to do with the amount of money being spent, but with the wisdom of spending it."

Support for this submission is given by Burke, who observed: "Expense, and great expense, may be an essential part in true economy."

Expenditure divides itself into three main groups:

1. Materials.
2. Labour.
3. Other units of utility which are not associable obviously and precisely with any characteristic element.

It may be of interest to state that:

(*a*) Direct wages (drivers and mates) absorb practically 50% of the total all-in costs of a road transport undertaking. (*The Commercial Motor* Tables of Operating Costs corroborate this percentage).

(*b*) Fuel costs are 33% of running costs and 11% of all-in costs.

(*c*) Lubrication: the importance of this factor cannot be measured by the significance of the sum in the total expenses.

(a) It will thus be seen that the wage question is really of paramount importance. This does not of course imply that to secure lower costs, cuts in wages should be made. The management which leads off with this expedient discloses poverty of thought, and at once confesses its inability *to manage*. Attention is directed to the point solely to emphasise the necessity for the management giving close attention to the specific condition of seeing that the workmen and staff are giving "value for money," and that they realise they are rowing in the same boat as himself, although possibly, to quote an old tag, with somewhat different sculls.

The need for psychological study of the employee, as a factor in securing low costs in conjunction with satisfactory working conditions, is at last being grasped by those in authority, and is particularly desirable in the case of foremen; not infrequently the best foremen are found among the men themselves, and their selection warrants special care, as good results in some shops are directly traceable to the kind of man employed in a supervising capacity.

(*b*) Some remarks on the fuel question are made later on p. 183.

(*c*) Time does not permit me to expatiate on the important part lubrication plays in keeping down running costs. I have referred to the question of quality of oils on page 184, and will therefore content myself at the moment with observing "Take greater pains to ensure that the lubricant gets there, rather than devote your time to the quality of the stuff," but the point I wish to emphasise at this juncture is the need for special heed being given to the exclusion of dirt and foreign matter generally from all bearings. Observe carefully all covers, and those parts immediately adjacent to the filling orifices, and—another important condition—see that the bung-hole and neighbouring parts of oil drums are kept scrupulously clean, as also the smaller vessels for filling oil tins and the like. Oil containers with properly fitted taps should, however, be recognised as necessaries by even the smallest concern, their cost being viewed in the light of an insurance premium, whilst the recently marketed oil-distributing apparatus mounted on rubber-tyred wheels to facilitate movement over uneven ground, is to be commended to large businesses, as, by such a system, not only is the oil supplied measured off and accurately recorded, delivered under pressure through a flexible pipe, thus saving time, but it is also passed through a straining filter. The use of such apparatus should considerably simplify the somewhat unpleasant task of emptying and replenishing the oil supply in engine sumps.

At the head of this Paper I have quoted a remark by Henry Ford which I consider to be as profound a truth as anything in the sacred gospels. Indeed

I regard Henry Ford as the Messiah of Modern Industry. Some may think my enthusiasm has run away with my judgment, but my admiration for Henry Ford is shared by John D. Rockefeller, who called the Ford Motor Co. "the industrial wonder of the world." If after reflection one agrees with the observation quoted, which is not a caprice of speculative ingenuity, but a rigorously deduced conclusion, then it is equally true to say that your present business, whatever it may be, and as a practical corollary, your net profits, are lower than they ought to be. Is it not fairly certain that one or two sections of your organisation are not run on the most creditable lines?

With the Main Expense Schedule in front of the General Manager and Operating Engineer, exactly what is the problem to be tackled? Obviously the object is to bring about a reduction of costs, costs in this sense embracing all charges and expenses. Let us endeavour to tabulate in a concise form the proposition:

To reduce Running Costs by lowering

- (*a*) fuel consumption and fuel and oil prices;
- (*b*) the cost of man-hours on maintenance repairs;
- (*c*) establishment charges; by elimination of unnecessary procedure and simplification of managerial methods; by reduction or by being *deferred*.

As already observed, it is a platitude to state that Running Costs will vary appreciably through physical (topographical) factors (state of roads, surfaces, gradients, etc.) beyond the control of the Operator, but it is an element not infrequently overlooked, or at least underestimated, when making motor transport contracts, or endeavouring to secure comparable results with another service.

It does not require long experience for the Operating Engineer to realise the fact that the principal item of expense in Road Transport in which he can "have a say," to put it colloquially, is maintenance. Low initial cost of the vehicle may quickly fade into the background.

Professor J. S. Haldane, in dealing with the complex biological subject of organism and life, points out that "machines do not maintain themselves; they do not mend themselves; they do not reproduce themselves;" but, as was lately observed by Major Beaumont in his recent paper "Some Aspects of Road Transport," read at the Institute of Transport Congress at Harrogate in May of this year: "There are instances of owners who have operated first-class vehicles at the rate of 1,500 miles a week, with little or no service attention, and have complained of the wear and tear after 25,000 to 30,000 miles and before repairs have actually been required." They believed, if they thought at all, that machines could maintain or mend themselves.

In considering maintenance we come to the enormously comprehensive subject of vehicle design—much too large a question to discourse upon within limits of this Paper, except to draw attention to a feature having an important bearing on maintenance cost, namely, accessibility of parts, by which is meant facility for effecting adjustment on the road, and for carrying out replacements and repairs

in the workshop. In connection with the latter be it observed that labour is too expensive to be wasted unnecessarily and, moreover, it involves that peculiarly insidious but most important expense, vehicle lost time; for it should be remembered that a lorry standing in the repair shop involves at least two charges: one, the repair bill itself; two, capital standing idle; and possibly a third, contingent losses of work and labour being held up for transport of materials; or substitution.

Another important feature is design and materials in relation to the specific suitability of vehicles for the particular work upon which they are employed. Speed, supervision, and lubrication by drivers, are all matters which have an important bearing on the behaviour of vehicles, reflected in running costs, and consequently need more than casual attention from the Operating Chief.

One self-evident fact might perhaps be mentioned in connection with maintenance economy: standardisation of the vehicle fleet to one make (possibly various sizes of one make, and from a maintenance viewpoint I favour the idea of engines and gear-boxes as separate units) generally means carrying a smaller stock of replacement parts, with consequent saving in store-room, store-keeping and sunk capital.

Maintenance charges are, as a rule, largely made up of labour costs due to carrying out a repair in an old-fashioned way. A good quality portable tyre inflator is as essential as the provision of the best apparatus for speedily effecting tyre changing. With the advent of giant pneumatics attention in this direction is even of greater importance than hitherto. Portable fitters' benches mean much saving of time of men running about for tools and small consumable stores.

As stated a few paragraphs above, *working days lost* is a phase which should be specially stressed. Fuel, oil, and wages are readily recorded, but such is not usually the case with an equally important, yet more subtle expense—lost time. A vehicle standing in the repair shop will, as already observed, generally represent a far heavier charge than the actual cost of repair.

Maintenance costs can be substantially reduced if the mechanics in the Repair Shop are conscientious workers, and *exercise special care in reassembling units after repair*. Tightening up combustion heads, or covers secured by a number of bolts or studs, are examples where carelessness comes home to the management sooner or later; undue strain, which may have been placed upon such parts, ultimately causing a fracture, for which the manufacturer or designer, or both, may be blamed.

It is very helpful in this connection to cultivate a decent feeling with the men, occasionally mentioning such failures as having occurred to somebody else through ignorance on the part of that somebody's mechanic—thus instilling a sense of "pride in work" in your own employee—a real and great force, comparable with the team spirit in football or cricket, or *esprit de corps* in a regiment.

The creation of an atmosphere of intelligent service cannot of course be achieved by *instructions* from the Chief; a late colleague of the author tersely expressed the principle in these words: "The proper spirit can only be caught—it cannot be taught."

In the matter of keeping records special care is necessary to keep only such which have real practical value as distinct from those that are merely interesting, and that in as economical a manner as is possible. It is easy to keep many records which provide no really useful information and which do not justify the time and work expended on them.

Although Henry Ford on a memorable occasion, when he was confronted with a financial problem in 1920, came down with a heavy hand on certain masses of statistics it should not be inferred that he does not keep statistical records, nor that they can be eliminated from a well-managed concern.

While the keeping of records, *i.e.*, the accumulation of significant data, is in some degree akin to the keeping of accounts, it is nevertheless distinct. Accounts will show what has been accomplished from the financial point of view, but records will enable valuable comparison to be made between various vehicles, drivers and services, and indicate a useful line of action for the purpose of checking leakages. Figures, *qua* figures, are of little value; intelligent interpretation is called for to discern their intrinsic value.

To give help in the direction indicated it is suggested that consideration be given to the employment of graphic charts, of which I have made extensive use, both in civil and military spheres. Considerations of space have, however, compelled me to eliminate completely from this Paper the notes which I had prepared on the subject.

The Controllers of large Transport Organisations, having numerous branches or depots in various parts of the country find it increasingly difficult to maintain touch with the activities of ever-expanding departments, and to such the institution of a Graphic Chart Section to provide a ready visualisation of affairs (and blue prints made from the original chart may usefully be employed for general circularisation and comparison) is almost a *sine qua non*. But only in a slightly less degree should the Smaller Organisation regard Graphic Charts as matters of necessity.

Printed Forms.

Public Departments (State and Municipal) are frequently scoffed at because of their apparent love of forms, with innumerable ruled-off spaces for the insertion of information. Probably many still have unpleasant recollections of " nil returns must be submitted." I have had sufficient experience to appreciate the value of specific blank spaces in forms and record returns. If one desires to ascertain definite information by correspondence from another party the sure way to obtain that information is to provide a blank space which " hits him in the eye " until he has spilled some ink giving attention to the detail. Take, for example, a driver's log sheet; if definite spaces were not provided thereon for recording miles, fuel and oil, and so on, it is quite certain that one or another would be frequently omitted. There is also in motor transport management a psychological view-point in the filling up of forms; drivers are not as a rule " scholards " enough to like the job, and wherever possible they will shun the task; so keen is their desire to

escape writing up a report in the daily log that some will take especial care to avoid a breakdown occurring. This is an aspect that has probably not occurred to many. If anyone knows a better method of obtaining information from one or many different sources than by means of spaced and ruled forms I would be glad to hear about it. Reference to the income-tax forms is perhaps too painful to many, but there is little doubt that Somerset House folk know their business well.

OVERHEADS.

There is an ancient Egyptian Compendium, now in the British Museum, which announces in its title, with much highfalutin' embroidery, that it gives information on the whole range of divine and human knowledge to the ignorant and learned alike. Apparently the subject of "overheads" is neither divine or human, for I failed to find any dissertation upon the question under discussion. The terrible thing about overheads is that it is difficult to live with them, and impossible to live without them.

I have been at some pains to find in standard works a really comprehensive definition of the term "Overheads," but without success, and whilst in this gathering there is not likely to be any misapprehension of its meaning, it may be useful to propound a terse definition of the term.

"Overhead expenses" include every chargeable component, other than wages and materials, employed in the functioning of a business.

Owner-driver concerns invariably take a rose-coloured view of the revenue possible, with corresponding under-estimation of the outgoings. But one-man concerns are not alone in their ignorance of the factor, for when I had business dealings with certain firms in the Midlands in the "early nineties" I ran up against some quaint ideas of overhead costs, which can best be expressed without exaggeration on these lines:

Myself: What can you make me two of these for?

Manufacturer: Well now, let me see! Four hours man's time, say 5s.; material, say 5s.; that's 10s.; add a bob for profit. Price 11s.

Observe the simple costing system! No fooling about with on-costs and percentages for this and that!

Result: Order placed by me. By the way, this firm is no longer in business.

To emphasise the nature or actuality of the constituent "Overhead and fixed charges generally," I beg leave to digress for a moment to show how an automobile, or any other article of commerce, may be sold at less than *ordinary cost* of production and yet be the means of realising a profit for the manufacturer.

One has no need to delve into Higher Mathematics to demonstrate the effect of fixed (overhead) charges on the cost of production. The following simple example clearly shows their effect, but it is necessary to observe that scientific costing is essential before increased output and lower selling prices can be ventured upon. Incidentally, this example may throw a little light upon the much advertised procedure of our American competitors.

Original output: 500 cars per annum.

Wages and material		£30,000
Fixed charges		30,000
	500)	60,000
		£120 each

Output increased to 600 cars per annum

Wages and material		£36,000
Fixed charges		30,000
	600)	66,000
		£110 each

Thus by increasing the output by 100 cars the cost of the original number is reduced by £10 each, giving the manufacturer an increased profit of £5,000.

If, therefore, he chooses to dispose of the increased production of 100 cars as demonstration models to selected agents at £95 each, he makes a loss on them of 100 x 15: £1,500. *But* he would have an increased profit of £3,500 on his total business.

It may be urged that the example cited deals only with production units, but the Road Transport Operator who is producing and selling "Road Miles," can adapt the principle outlined to his commodity and demonstrate its soundness.

If the large railway groups which recently obtained Parliamentary Powers to engage in road transport work had been put under the obligation, as was at one time suggested, of keeping separate depot or town costs, the "Overhead" factor carrying with it a percentage of Administration Expenses (15) would have been of considerable importance so far as their Expense Account was concerned.

Now let me strike a cheering note in this mournful tune of costs.

An item not infrequently overlooked by ancillary transport undertakings is the distinct advertising value which exists in well-kept vehicles, and in this connection the Yanks have a slogan that "painting pays dividends." Does your company take cognizance of this point in its Profit and Loss Account, in the form of a book credit? Probably not, because if brought into accounts it might raise the highly contentious question of liability to Income Tax! Receipts in respect of outside advertising are obviously revenue and therefore taxable.

Many firms whose names will readily occur to you, obtain a full measure of the advertising value of a commercial vehicle by fitting special bodies designed to represent their particular article of merchandise, e.g., Palmer Tyre Co. (large tyre section), Thermos bottle body, Electrolux cleaner body, Fountain-pen body, Hot-water geyser, Odol dentifrice, Watney's beer-barrel body, Spiller's food (plate-glass show-window).

Apart from such striking advertising displays, smartly conditioned bodies, with their owners' name in striking characters, are not without advertising value. It is a matter for considered judgment how far one should sacrifice utility by departing from the useful rectangular for the purpose of securing advertising value.

If there is a difference of opinion as regards the advertising value of a transport vehicle body, few will dispute the view that dirty and ill-cared for vehicles are a reproach to the firm using them, and brand the house in a corresponding degree.

It was observed, on page 176, that we should ascertain how overheads could be eliminated, reduced or *deferred*. Doubtless the last term puzzled many hearers and I will now proceed to throw light upon the expression.

Problems incidental to the distribution of Overhead Expenses are treated in a manner, startling in its novelty, in a pamphlet prepared by the Department of Manufacture of the United States Chamber of Commerce, Washington, D.C. Originally issued in 1924, when industry generally was experiencing the results of the severe depression following the World War, the pamphlet was amplified and re-issued in 1927, and recently came into my possession through the courtesy of my friend, Mr. Coker Clarkson, General Manager and Secretary of the Society of Automotive Engineers, New York, to whom I applied.

The gist of the principles—somewhat daring to our conservative nature—outlined in this thought-provoking brochure is expressed in the following :—

A Normal Year—the Business Standard.

> Our cost systems are far too rigid. Under cost methods still largely in use, overhead expenses are spread too thinly in times of forced production and, massed too heavily in periods of slight demand and production, giving in the former case costs that are artificially low and unfair to the management, and in the latter case costs that are artificially high and unfair to the public, and moreover costs which the market will not sustain.
>
> For the sake of convenience, we split up our business into years and treat each year separately. On the basis of a fiscal year we determine the profits for the period and distribute them to the stockholders accordingly. This is well and proper, but when it comes to the distribution of overhead expenses to our product cost for the purpose of making or gauging our selling prices it is desirable, indeed important, to select a longer period than one year, or, in fact, consider the actual overhead expenses and volume of business for several years.
>
> There are expenses, which continue whether the plant is idle or in operation, expenses that moreover, bear no direct relation to output. Cost systems should provide that these expenses, usually designated as overhead expenses, should be absorbed and pro-rated on the basis of a *normal year*—that 100° mark on the business thermometer. Thus, in a season of unusual production—production exceeding normal—the overhead should be more than used up in costs, and a surplus out of overhead cost created to take care of those periods of the year when the output is below normal and the overhead charge not fully absorbed.

(A simple illustration of the working of this overhead appropriation is then given in the pamphlet).

This method of cost procedure has numerous advantages. For one thing it will eliminate the needless throttling of business by the impracticable attempt to load sub-normal production with greater charges than can or should be borne.

Operation under a normal year basis.

The determining of a normal year is not an easy matter. It requires a long look behind and a far look ahead. It is by no means sufficient to accept the operations of the preceding year as the sole standard. The normal year is different for a new organisation or industry from what it is for one long established.

To establish normal unit overhead charges, two things must be determined :

(1) Normal overhead expenses for the various department of the business

(2) Normal production.

When the normal overhead expenses are divided by the normal production, the result is the normal unit overhead charge

Necessary Cost System Adjustments.

The accounting device used to secure operation on a basis of a normal year is the now familiar one of the Reserve, or a modification thereof.

For the purposes of illustration, although the situation is not identical, let us recall how a simple reserve, such as the reserve for bad debts, operates.

Some Misunderstandings Clarified.

I. The setting up of estimated overhead charges based on a normal year does not mean the abandonment or compromising of actual overhead costs.

II. It is not the intention to forego or wipe out a single dollar of overhead expense that can be legitimately and fairly charged to operation, sales or administration.

Found Feasible in Practice.

What has been stated is elementary and suggestive. Its aim is to stimulate interest and encourage such changes as are necessary to meet progressive competition.

Upon inquiry of the Department of Manufacture, establishments in such widely separated industries as paper, cutlery, envelopes, stove, and metal products are operating on the basis of a normal year and upon this basis distributing overhead.

The pamphlet concludes with this sage observation :—

The treatment of overhead in the way indicated is not a panacea for all our industrial ills. The control of overhead in a manner fair to the business man as well as the consumer is one step and only one step toward realising more stable prices and eliminating those wild fluctuations that culminate in industrial depressions.

Presumably it is much too revolutionary a step for our Board of Trade to assist the industrial community with a pamphlet on the subject, if not on similar lines. But perhaps one may inquire what our Chartered Institute of Accountants or similar body is doing to assist business in the direction under discussion ?

Now taking the figures given on page 180 and applying *deferred* appropriation of overhead charges, say, for example, 40 per cent., we get this:

500 cars per annum.

Wages and materials	£30,000
Fixed charges £30,000, 60 per cent. ..	18,000
500)	48,000
	£96 each

And with the increased output of 600 cars per annum.

Wages and materials	£36,000
Fixed charges £30,000, 60 per cent. ..	18,000
600)	54,000
	£90 each

Fuel.—In the search for the most economical fuel it is frequently necessary for operating engineers to make numerous practical experiments. Although the only help I can give in this connection is somewhat of a negative character, it may nevertheless be of some service.

From time to time careful records, by a simple and not costly method, have been kept of the m.p.g. secured over recognised regular services by a large number of vehicles and some interesting, but at the same time peculiar, results have been registered. Tests of well-known popular spirits (not job lots, which occasionally come on the market) - let us call them A, B, C and D– have been made on three principal types of vehicles, say F, L, H and M (Fords; light vans (other than Fords; Heavy Lorries; and Motorcycles); and it has been found that whilst the spirits may come out quite definitely in order of merit A, B, C and D in the case of Fords, the same order did not hold good for any one of the other three types. Some months later further tests showed that the order of merit with Fords was probably B, A, C, D, and other variations of order in the remaining types. Similar fluctuations arose when trying various number three grades of some of the suppliers, for test purposes these being of course treated as new fuels. It should be observed that none of the fuel companies had knowledge that the tests were being made and that the spirits tried out were purchased in the ordinary way of trading. Presumably the vacillating results were due to variations in the quality of spirit. In order that the personal equation in these trials should be eliminated as far as possible the tests were always made on a very large number of vehicles and in many different parts of the country.

One useful fact does emerge from these tests, and that is that the best spirit for heavy lorries is not necessarily the best for other types, "best" being used in the sense of m.p.g.

Many years ago I found as the result of a long series of tests on the same heavy lorry, over the same long route, but with different drivers, that a mixture of three

parts of No. 3 petrol, with one part of Benzol, gave the highest m.p.g., but more recent tests under similar conditions failed to confirm the early results, and running on straight petrol was resumed.

This seems an appropriate place to offer a brief observation upon ethyl. Much alarm (some real and some " interested ") has from time to time been expressed as to the poisonous qualities of ethyl gas, and not infrequently, tests, by more or less competent experimenters, have been carried out to determine the degree of danger, if any, of using this particular fuel. The only observation I wish to make is this : that whenever a new chemical compound is invented or discovered, difficulty in the manufacture and use frequently arises in the early stages of its introduction, *but it is usual for all such difficulties to be overcome by the application of simple precautions*. There was a similar apprehension when celluloid articles were first introduced, and still later, when petrol was first used.

Oils.—In a similar search for the most economical lubricating oil it might at once be mentioned that really satisfactory supplies (satisfactory both as regards quality and price) are obtainable from purely British manufacturers ; the origin of the crude may not, of course, be British, but when the usual refining, distillation and blending operations have been carried out, satisfactory and consistently good results have been secured from purely British manufacturers.

The practice is probably universal for all vehicle manufacturers to impress upon their customers the importance of using only high-grade oils if they wish to secure good service. Most of us have found it difficult to follow the petty whimsies and fine-spun casuistries of the oil traveller, but space again bids me take heed, and on this occasion it should merely be observed that " high-grade " oil is not necessarily synonymous with " high-priced " oil. I must content myself with the expression of what I believe to be a golden rule :—

Continuous skilled care of the condition of the bearings and shafts is essential if the lubrication problem is to be successfully mastered—" mastered " in this case embracing the all-important matter of economy in consumption. If the practice enunciated be diligently pursued there is hardly any factor in vehicle maintenance that will better repay one.

As must have been the case with many other fleet operators, I was grievously troubled at the loss of gallons of cylinder oil when large engines were taken down for overhaul or other reason, and very many years ago I tried the scheme of again bringing into use the drawn-off oil. The oil drawn off from one type of vehicle (the small vessel used for drawing off was kept scrupulously clean) was stored in a receptacle and allowed to remain for a week or two, thus giving the fine solid particles (dirt or metal) in suspension time to settle. A quantity of the used oil was then put into a large cylinder and the upper strata syphoned off into a filter chamber—electrically heated, to facilitate flow and to drive off any lighter diluent such as petrol—and the oil thus treated was returned into the engine sump after being mixed with an equal quantity of entirely fresh oil of the same manufacture, *i.e.*, 50/50 old and new oils. This apparent misgiving (adding fresh oil) on my part

was due to a slight doubt that the old oil might possibly have dimini lubricating value.

I am fully aware that it is not possible by simply filtering the used oil to el the very finest particles of carbon, but I countered this objection, when raised, by inquiring if the objector was prepared to demonstrate that such minute soft particles were in themselves deleterious; it may be rank heresy, but I do not think any harm is caused by their presence, believing them to partake somewhat of the nature of a solid lubricant, *e.g.*, natural graphite, asbestos and the like, and I would be glad to hear the views of oil technologists on the point. Prominence to this oil kink was given a year or so ago by one of our leading Transport Journals. This fact, at any rate, emerged from my tests: no breakdown, or excessive wear on bearing surfaces was ever traceable to the use of the mixture and the saving in a year's consumption ran into a considerable sum. Recent inquiry has elicited the fact that the practice thus instituted still continues with substantial savings.

The subject of lubricating oil cannot be more aptly closed than by repeating an observation made many years ago by my friend Mr. Meyrick Jones, A.M.I.M.E., which expresses most succinctly the whole question of lubrication. "Generosity is expensive and messy, niggardliness is dangerous." Pages cannot point a moral so effectively as these few words.

Effect of Design upon Maintenance.—Time preventing too great an elaboration of design features, such as Brakes, their functioning and methods of operation; Carburation characteristics, etc., etc., and bearing in mind that the subject is Cost Reduction, I must content myself with inviting attention to one point only, namely, weight reduction.

Whilst time will not permit a discussion of the vexed question of unsprung weight, the subject is mentioned merely to provide the opportunity for urging that designers should continue to study this important factor in, among other things, tyre costs. From unsprung weight it is a very short step to the consideration of springs and spring design, but in passing on rapidly to other problems I desire to observe that there is still fame and fortune awaiting the *enfants perdus* of Science, as they have been called, who will give us a spring that while functioning efficiently with a full load does not hammer unmercifully human, as well as inanimate, freight, when partly loaded.

Students in "Spring Design" will probably be told that the ground has been thoroughly covered and nothing more can be done. It is possible, of course, to prove by logic almost anything cannot be done, but the deuce is that whilst we are arguing, someone is doing it, so I trust that "automobile evergreens" will continue "hopeful," remembering "Conquest ensues where courage leads the way."

It is of the utmost importance that designers give special attention to keeping down dead and useless weight in both body and chassis, as any unnecessary weight continuously and cumulatively makes its influence felt under so many heads, as to be almost impossible to assess with any degree of accuracy. Many years ago

when the Post Office Department instituted its own model of bicycle, I expended a large amount of time and trouble in effecting a reduction in the weight of the machine without unduly impairing its strength for the arduous conditions of service, and finally the question resolved itself into saving an ounce here and an ounce there. Similarly I believe it is up to designers of commercial vehicles to jettison a pound here and a pound there. In the case of the bicycle the results achieved meant reduced nervous exhaustion and less expenditure of muscular tissue on the part of the rider, but in the case of the commercial vehicle it means less expenditure in various directions of pounds, shillings and pence. Incidentally, in this connection it is not irrelevant to mention one of the great advantages of road over railway transport, namely, the great reduction possible in the strength *and weight* of packing cases and materials for most classes of merchandise.

People have for many years associated weight with strength. Plenty of beef in design may look well at Olympia, but the economical value of low weights, consistent with essential strength and rigidity, is of primary importance in economical running, and it behoves designers to give more than cursory attention to this subject. Unnecessary weight means waste; as Henry says, " Weight is only useful in a steam-roller. There is but little doubt that the employment of steel pressings scientifically welded or of some of the lighter metals and woods, or a combination of both, on parts where sheer strength is not of paramount importance, is one direction in which improvements might be made.

Mainly as a provocative I seriously submit that most designers are largely deficient in the dramatic instinct, which enables a man to put himself for the moment into the condition and mood of men entirely unlike himself in training and conditions, really an indispensable element in the make-up of an efficient designer. Granted it *is* difficult for a man with the engineer's knowledge to visualise the ignorance of the average user of vans. The dramatic instinct cultivated in other spheres—administrative and managerial—is not, of course, without profit.

Better co-operation between the chassis and body departments is called for. Erecting and fitting is an easy job in the makers' works where all adjustments are made with free head room; when the stature of the late Little Tich is standardised by the S.M.M.T. or B.E.S.A. for all drivers and mechanics, then detailed adjustment on the road upon carefully stowed away parts may be possible. Many accessories, too, might be considerably lightened without lowering their efficiency.

Some folk imagine a job cannot be done too well, a view to which I do not subscribe. There is quite a lot of work too well done; it will probably be agreed that here we have a question of peculiar difficulty, as if a comparatively low standard of finish be permitted for any part, what will be the effect upon the mechanics, when working upon other parts, demanding a higher standard? It may be the solution would lie in a higher inspection standard; perhaps where craftsmen are not involved and production is pure repetition in the hands of

machine tenders, the point does not become acute. But how about a highly finished exterior of a cylinder casting? Does it produce another H.P. or not? Again, machining the curved surface of an oil inspection door, and similar work of a costly nature, can be completely dispensed with by using an efficient blanketing material, which I believe I was the first to use some few years since. Believing in passing on a good thing, especially as it is British throughout, I do not hesitate to name the material in question, "Langite," made by the Cork Manufacturing Company of Chingford. Although apparently most manufacturers seem to be using this in one form or another, very few seem to be taking full advantage of its use to eliminate or reduce machining.

Depreciation.—I prefer to put this as a Running Cost rather than a Standing Charge, although it is agreed depreciation goes on even if, and when, the vehicle is standing idle for any appreciable degree.

As regards the method of calculating depreciation I would refer to my Paper on the subject read before the Society of Automobile Engineers in America in 1913 and published in the Proceedings* of the Institution of Automobile Engineers. The only additional observation I have to make is that as the result of subsequent experience (*i.e.*, subsequent to 1913) and discussion with my late colleagues in the Post Office, an average life of the various classes of vehicles for the purpose of depreciation can be decided upon and depreciation calculated on the straight line method—with a residual value of 20% in each class of vehicle—which, by the way, may range from a motor-cycle combination up to a 12-ton lorry. Obviously the residual value will vary in proportion to the amount spent upon maintenance, and the almost perennial cuts in market prices of vehicles.

It will be seen in the Main Expense Schedule that I have differentiated between the chassis, body, etc., a practice which is recommended, especially in view of the fact that many costly bodies have now been brought into use, which should outlast two or more chassis.

Interest Charge on Capital.—There are at least two schools of thought, holding diametrically opposed views, on the question of inclusion in the operating costs of an interest charge in respect of capital, and whilst recognizing that the question is extremely polemical, I would express a bias for the inclusion of such a charge in the Total Bill of Costs. Be that as it may, there can be no question that if money is borrowed to function a business, as, for example, to buy vehicles in a road transport haulage company, then any interest charge payable on the borrowed money is an operation cost, and must be borne accordingly.

Insurance.—It is perhaps a moot point as to whether vehicle insurance should be for "all risks" or only "Total Loss and Third Party Liability." So far as accidental damage is concerned, it is at times difficult to differentiate between accidental and ordinary maintenance repair work. Where one has a good repair shop, or moderately skilled mechanics are employed, numerous minor repairs are effected and debited to maintenance that might equitably be claimed under

* Vol. VII. p. 527, *et seq*

MAIN EXPENSE SCHEDULE.

Running Costs.	Standing Charges.	Overhead Expenses.
(1) *Fuel.* (2) { *Oils.* *Grease.* *Cleaning Materials.* } (3) *Maintenance* (Material and Wages) Chassis. Body. Accessories and fittings. Tools (including rags and waste). (4) *Depreciation* Chassis (less tyres and wheels). Body. Accessories and fittings. Tools. (5) *Tyres* (new and repairs). (6) *Wheels* (repairs). **Note.**—Additional items must obviously be added to "Overheads" where they are special to particular work, such as "tickets and way bills" in 'bus practice.	(7) *Interest on Capital.* (8) *Insurances* Vehicles. Health and Unemployment. Employer's liability. Fire. (9) *Garage* Rent and Rates. (including water). Maintenance repairs and fixtures. Power. Heating. Lighting. Cleaning. (10) *Wages* Drivers. Mates. Storekeepers. Cleaners. Mechanics and Foremen. Experimentalists and Testing Staff. (11) *Clothing* Uniform. Protective. (12) *Licences* Vehicles. (13) *Depreciation* Garage. Garage fittings. Garage plant and tools. (14) *Waste* Packing materials, ropes, sheets, and small tools (files).	(15) *Administration* (Directors' fees, whole or proportion). (16) *Management* (Salaries). (17) *Supervision.* (18) *Travelling Expenses.* (19) *Commissions* (Travellers, etc.) (20) *Clerical Salaries.* (21) *Office* Rent and Rates. Insurances (staff and building). Equipment (and maintenance). Heating. Maintenance repairs. Lighting. Cleaning. Depreciation (furniture and appliances). (22) *Stationery and Printing.* (23) *Telephones, Telegrams and Postage Carriage.* (24) *Advertising.* (25) *Subscriptions and Donations to Trade Associations and Trade Journals.* (26) *Bank Charges.* (27) *Incidentals* (expenses not already classified). (28) *Legal Costs and Fines, Patent Fees.* (29) *Audit Fees.*

an insurance policy, but the trouble and difficulty in coming to an agreement renders such procedure not worth while. Probably the solution is to be found in "the assured bearing the first part of each accident," with a corresponding reduction in the premium. As regards pleasure vehicles, it is a difficult point to decide; much can be said on either side. But it is thought that "Total Loss and Third Party Liability" insurance of vehicles will generally be an agreed item—and even if the organisation is of sufficient magnitude to carry its own insurance, then a charge (the recognised standard rate made by an Insurance Company) should be debited as an operating expense. This will, at any rate, make the operator's costs comparable with those of another.

In conclusion: King Solomon, who, in his time, was one of the greatest employers of skilled labour, a real Captain of Industry, as the term runs, and who, rightly or otherwise, is credited with an abundance of wisdom, discovered and placed on record (Proverbs xi, 24), "there is that scattereth and increaseth yet more." I would commend this ancient and sterling advice to those of my hearers, who, possessing information on the points raised, are not disposed to pool their knowledge

Whilst it is much easier to criticise than to correct, fair criticism is welcomed, for the critic has his proper place in the scheme of things if only as a constant spur to efficiency

BIBLIOGRAPHY

Whenever I have consciously derived assistance from the work of previous writers due acknowledgement has been made; should I have inadvertently put forward as original an idea previously published, I can but observe that "when a thought has lain molten in a man's brain and been hammered into shape on the anvils of his imagination, it is his own, although a thousand mighty voices may have given utterance to it before."

"My Life and Work" by Henry Ford (Heinemann).
"My Philosophy of Industry" by Henry Ford (Harrap & Co.).
"Extracts from Chordal's Letters" (Amer. Machinist Co., New York).
"Factory Administration and Accounts" by Elbourne (The Library Press).
"Mechanical Road Transport" by Conradi (Macdonald & Evans).
"Overhead Expenses" (Chamber of Commerce of the U.S. Washington D.C.).
"Industry Fifty Years Hence" by Arch. Crawford K.C. (Journal of the Royal Society of Arts, Vol. LXXVI, p.592).
"Report No. 29. British Industrial Research Fatigue Board" (H.M.S.O.).
"Economics of Motor Transportation" by Grupp (Appleton & Co.).

DISCUSSION.

THE CHAIRMAN said that before he invited general discussion, he would like to make a few remarks, though he would not attempt to deal with the technical side in regard to the design of the vehicle, the fuel to be used, and similar matter. On the question of keeping accurate costs, the lecturer had referred to the large number of headings on the customary forms. The speaker was of opinion that the success

of any scheme of accounting of costs depended very largely upon the way in which the headings were laid out, and the study which was put into them. The staff, when they came to fill in the records, should never have any hesitation as to the heading under which a particular item should be placed. If sufficient thought were given to the headings, so that there was no possibility of their being misunderstood, something reliable in the way of results might be expected.

The lecturer, in speaking of the lengths of pedantic accuracy, had instanced the case of Mount Everest, which, he learned in his early days, was 29,002 feet high. Nevertheless, the speaker had found that if one were making a statistical statement, it was the easiest thing, after all, to take the shillings and pence, or the decimal points, and not to rely upon the broad even figures. If one did adjust figures to a broad level, leaving out the shillings and pence, it was very likely that a great deal more time would be wasted afterwards in finding out which item had been adjusted too loosely than would have been spent at the beginning in a close computation.

With regard to the lecturer's definition of "overhead," namely, "overhead expenses include every chargeable component other than wages and materials employed in the functioning of a business," he felt that the definition was not a good one from the manufacturer's point of view, because the overhead expenses included a very large amount of wages. He would like to see a better definition than that, though he was not going to attempt one himself.

With regard to the American scheme which the lecturer had described, of carrying forward a portion of the fixed charges into the next year, this was very good if the matter were taken from the sales point of view, but at the end of the year when the balance sheet was placed before the auditors, they were not likely to allow something to be carried forward as an asset which, while not at present an asset, it was hoped would be such in the near future. Therefore, the carrying forward of this portion of establishment charges depended upon the ability to fix upon a normal year. The difficulties which he himself had encountered in this respect might not be the difficulties of others, but since the war, or since the slump in 1921, efforts to get down to a normal year had been wholly unsuccessful. This was because of improvements and alterations in design and manufacture, and the distribution of establishment charges did not stand still, so that alterations had continually to be made. He supposed that if they could sit down and make one kind of vehicle, and one only, over a number of years, normality might be reached, but under present conditions he did not see how, at any rate in commercial manufacture, the normal year was to be obtained.

There were very many ways of distributing overhead charges. The rough and ready method was to take a percentage on the labour and material. That was a bad method. Another rough and ready method, rather better, but still bad, was to take a percentage on the labour. The problem was that if a vehicle were made it had to be sold as one unit, and also to be sold as 500 units—that is to say, the manufacturer must know the cost of the parts if he was to do the thing properly. The only way of distributing the overhead charges with approximate correctness was to distribute them on the basis of hours worked. The hours worked in the various departments were obtained, the expenses of those departments were also taken, and the expenses placed on the hours worked. The time worked by an apprentice might represent 3d. an hour, and the time by an ordinary workman 1s. 6d. an hour, so that to put the establishment charges on the basis of labour alone might give a result very wide of the mark. No proper distribution was obtained by taking a percentage on the wages; it must be taken on the time actually worked.

With regard to depreciation there was one interesting point. Here he noticed what he thought must be a misprint in the printed paper, which spoke of a residual value of 2 per cent. in each class of vehicle. The lecturer had said 20 per cent. But he was hoping that it was 2 per cent., and honestly he felt that 2 per cent. residual value was a great deal nearer the mark than 20 per cent. under present conditions.

MR. A. J. WALDEGRAVE (Deputy Comptroller and Accountant-General, G.P.O.) said that as a very old friend of the lecturer's, and one who had been in fairly close touch with him until the time when, to the great regret of his colleagues in the Post Office, he had to give up the work, it had given him great pleasure to listen to the paper, the more so because the lecturer's racy manner made one feel that the effects of the illness from which he had been suffering were disappearing. The lecture had brought out a very large number of important points in connection with the profitable running of a motor service. The point of chief interest in the paper to those who were concerned with the accounting side was perhaps his treatment of overheads, and here he must agree with the Chairman that the lecturer's definition of overhead costs left something to be desired; it seemed to him to be too simple. Everyone liked simple things if they could be obtained, and in that connection he might say that he appreciated the lecturer's preference for the straight line system of depreciation, which had the great merit of combining simplicity and safety. But there were cases in which it was possible to be too simple, and he thought the lecturer had been too simple in his definition of overheads. He had stated that overheads consisted of all expenses other than wages and materials. That was not a universal definition of overheads, as could be illustrated from a branch of the Post Office business, which corresponded, of course, with any shop business in this respect. In the Post Office, or in a shop, there must be a staff on duty from the time the counter was open until it was closed, and yet for a considerable part of that time no customer might be engaging the service of the man or woman on the other side of the counter. In the case of the Post Office the amount of unoccupied time in that sense—not wholly unoccupied, because, of course, people were doing odd jobs in the intervals—was very considerable; indeed it was so large that if he gave the figure it might be said that this was another instance of Post Office inefficiency. But in any business it was a large figure. Now, that amount, which was wage cost, was really overhead. This was a case where the wages were themselves overhead costs. Perhaps as a comparatively simple definition of overhead, he might suggest that overhead costs were the expenses which did not vary directly with the volume of business. They either did not vary at all, or, what was more common, they varied indirectly. He would say that expenses which did not vary at all only occurred in the case of absolutely stationary business; if the business was a developing one, the overhead expenses varied, perhaps spasmodically or perhaps regularly, but varied as a rule indirectly. The relation of that indirect, and it might be spasmodic, variation to the direct expenses was a matter for individual study. It could not be said to be the same in any two classes of business, or in any two businesses, but it was just the study of the relation between those two things which made the difference between the running of a business properly and improperly.

In running the motor business, for example, which the lecturer had left as a legacy to the Post Office, what, precisely was the business? Was it to run so many miles, or to deliver so many parcels? The postman-driver had to leave his vehicle to deliver parcels at a house; he might have to walk up the drive, and if it was a cash on delivery parcel, to collect the money, and all this time the engine might or might

not be running, according to the regulations and the way in which the man concerned observed them. But the running of the engine was of the nature of an overhead cost, although it was a running cost. Whether a thing was a running cost or an overhead cost depended partly upon the nature of the business, and this made it difficult to get down to units in a business like that of the Post Office. All the expenses which were going on, due to waste of time, whether the loitering of the driver, his failure to fit in closely to a schedule, or, perhaps, the accountant calling for accounts, and so on, if it could be cut out, was so much saving.

With regard to depreciation, he did not agree that this should be treated as a running cost. Part of depreciation was wear and tear that varied with the running, part was wear and tear that did not vary with the running, and part of it was simply due to lapse of time, or obsolescence, which took place whether the car was running or not. Again, he would suggest that the lecturer had tried to simplify things a little too much.

MAJOR E. S. BEAUMONT said that the lecture had covered a very wide field and it would take a long time to discuss the numerous questions which had been introduced. The question of overheads was capable of much further argument than could be given to it that evening. The lecturer had made one statement with which he was much in sympathy, namely, that the first requirement was that one should somewhere and somehow include all the costs. A mistake might perhaps be made in including what was a fixed charge in a running charge, or vice-versa, but what was wanted first of all was the final result, and secondly, the analysis of the costs.

A confusion seemed to exist between what he himself would regard as depreciation proper, namely, obsolescence, the writing-off of plant value on the one hand, and maintenance and repair charges on the other. Those were distinct things, and should not be merged in any way.

The question had been raised as to how far costs should be detailed. The speaker had had occasion to devote a good many years of his life to the study of these questions, and he had early come to the conclusion that the mere accumulation of figures and forms served very little useful purpose. The fundamental thing was to set up a system capable of being digested by those who were responsible for carrying out the work. He knew that there was a certain moral value attached to forms. If they had to be observed there was a probability of continuing good behaviour on the part of those members of the staff who had to be watched or directed. But the primary purpose of any system was undoubtedly to know where the money was going, whether things were improving or not, and again from his personal experience he found that these fundamental things could be ascertained with quite elementary recording systems. The Chairman had referred to the fact that the principles of precision and accuracy must be supported, but the speaker felt that when it came to statistical facts upon which sound conclusions had to be reached, simple systems, as a rule, sufficed very well.

The statement that not to spend money did not necessarily mean economy, was very true. It was only necessary to instance the fact that things could be bought too cheaply—that while less expenditure was incurred, such expenditure was incurred improperly.

Some of the figures which the lecturer had given might be criticised, but he had reminded his audience that the different transport organisations and businesses differed very greatly from one another. In fact, it was difficult to establish a proper comparison between one set of cost figures and another set. Not only did the circumstances of the business vary, but the systems employed by different firms varied,

and therefore, if one set out to exchange costs with the idea of discovering how one stood in relation to somebody else, it was inevitable to make allowances for certain factors which one or other had not got.

He agreed also entirely with the reference to invisible losses, lost vehicle time, or lost repair time. This was one of those things which were considerably neglected, and by no means sufficient attention was given to the waste transportation of dead weight. Even the majority of vehicle workers, he believed, failed to appreciate that the carrying of a spare can of petrol was often a source of weight and not of economy.

The question of the standardisation of the fleet with a view to achieving working economies was good so far as it went, but there was the old proverb about not putting all the eggs into one basket. Otherwise, to secure group standardisation was to do well. He cordially supported the reference for the need of a cultivation of good spirit in all workers engaged in the transport industry, whether those working on an hourly wage or those in responsible positions.

On the question of deferred overheads, he thought that the invention of that system should not be conceded to America. It had been tried in a variety of forms in this country, for example, in connection with the general overall costs of motor vehicles. So long as a man knew what he was doing and was making proper provision for the expenditure, he supposed that no danger was incurred, but for the rest so far as the overhead charges were concerned, and the prediction of a volume of business which would enable those charges to be spread accurately over the future, one was perhaps on dangerous ground.

MR. E. VICTOR AMSDON stated that during the war he was in a Government Department, and even in a Government Department it was quite easy to see the advantages that accrued from such an analysis of charges as had been given that evening. By means of this costing, the cost of tetranitrotolulol was reduced during the war from 3s. a pound, which was being paid to America at the start of the war, to somewhere about 10d. or 11d. a pound in Government factories in 1918. This was brought about merely by a co-ordination of costing in the various factories. For this reason he did not think any smile should be raised when the question of costing in Government Departments was discussed.

The Chairman had stated the very good rule that the financial accounts should be agreed with the costs, but the speaker would venture to say that in the majority of financial accounts at the present time things were not included which did come within the category of costs in a very large number of manufacturing concerns. The items to which he was referring and which might eventually be shown in the financial records were such things as losses. There were a large number of losses which had to be worked out into money, but which it was very difficult to assess. Then there was another point, namely, the question of the distribution of overheads, and whether it should be based on materials and wages, or on wage values alone. On this particular point the Chairman had said that he thought it should be placed on a man-hour basis, and the speaker was inclined to agree with him that the man-hour basis was a good one. If one took the management salaries which sometimes loomed rather heavily in the overheads, these bore relation to time, as well as did other things. There was some relation between the time for which the workers were occupied in doing a job, and time in its relation to overheads.

The question of decimal points had been mentioned as being a good way of keeping accounts. From the experience of keeping a private ledger in pounds and decimals of pounds, he found it much more difficult to discover differences

in that way than if he had kept the ledger in the ordinary manner in pounds, shillings and pence. The use of decimals had to be looked upon with particular care. If they were taken to three places and added together quite big differences were sometimes forthcoming.

MR. JOHN WALTON said that without wishing to be unduly critical of the lecture, he thought the lecturer had skated rather lightly over a number of points. In considering costs from a company's point of view there had to be considered the financial accounts, the operating accounts, and the engineering schedule of repairs. From an operating point of view, in a properly constituted business, care would be taken of the overheads which came from the engineering side as a fixed reserve, and these would be carried on right through the year. The engineer had to have detailed costs and to make up his overheads into detailed figures, which should be linked more or less with the reserve. He was inclined to agree with the Chairman that the man-hour system was the only way in which it was possible to obtain a satisfactory account for an overhead.

MR. VICTOR AMSDON hoped he might be permitted a further word about deferred charges. As the Chairman had said, it was difficult to get a normal year. If a normal year could be found so much the better, but within the normal year, if it was necessary to deal with short period costs, the question of seasonal variations came in. He would like to know whether it was advisable, supposing the output was low in one month, to vary the overhead charges accordingly.

MISS M. S. NEALL complained of the remark of the lecturer that cost accounting was too rigid. She would suggest, on the contrary, that rigidity was very necessary. It was essential that every expenditure should be known. If it was known it enabled one either to keep a department running or to shut it up, or, alternatively, to reduce the overhead charges. She maintained that all costs must be rigid.

She was also surprised that the lecturer had not mentioned the question of carrying full loads in transport. In the business in which she was engaged the endeavour was continually made to cut out unproductive time, and to reduce every cost; but when this had been done it was necessary to see that the vehicles were fully loaded.

So far as carrying costs to reserve was concerned, surely the ideal that the costing accountant should aim at was to cover his expenses month by month. If this were done the directors were in touch with the business as it was going. She suggested that transport costs should be covered in this way, even journey by journey and load by load.

CAPT. A. HUDSON desired to emphasise the point made by a previous speaker that the records could be over-elaborate. While it was desirable to have every item of costs, he was a firm believer in the necessity for cutting out unnecessary records. He could exemplify this by mentioning that a few years ago it was his privilege to go with a colleague to Germany to investigate certain features of Government transport in that country. The cost record system in vogue was examined, and he was amazed to find that a nation which was supposed to be a pattern of efficiency kept records such as a detailed mileage record for every tyre on every vehicle. There had been another example of the same sort of thing in the remark of a previous speaker about the Post Office. Was it a proper thing

to charge up to overhead or running cost that proportion of the vehicle's time while its engine was running when the man in charge got out to deliver a parcel? This seemed to him another example of what the costing accountant would do if he had the opportunity. The accountant set out on the one hand to bring down the overheads, but on the other he was bringing up the cost of accounting.

MR. WALDEGRAVE explained that he had not made any such suggestion as that the cost of the time while the engine was running should be computed. He had merely brought forward that case as a passing illustration.

MR. R. P. BRADLEY said that during the last three years he had been concerned in the winding up of a firm whose cost system consisted of nothing else but the cost of wages and material; account had not even been taken of rent, rates, taxes, power, light, or anything of the kind, and the firm had lasted for five years; it was true that it had a millionaire at the back of it, but even he got tired at the end. The trouble he found in business was not so much in learning what the overhead charges were, or what they amounted to, as in finding a method of charging up to individual jobs. He thought that every type of business had to find a costing system of its own. No costing system would apply to every business. For example, if the hours-wages basis were taken there might be one man in charge of a machine which cost £10 and another man in charge of a machine which cost £5,000. There must be a different overhead on the time of those two men.

MR. W. CULLY said that whatever the costs were it was essential to have them all. The lecturer's definition of overheads would read more correctly if he said: "Overhead expenses include every chargeable component, other than *direct* wages and materials." With regard to the insidious losses incurred by standing time, he thought it was important to refer to the training of drivers and the avoidance of accidents which brought not only direct loss, but bad repute and indirect loss, and the fatigue in labour, which he knew the lecturer had studied. The last speaker had mentioned the case of Woolwich Arsenal, and what he had said was perfectly true, except that it related to affairs twenty years ago. It was not true to-day. What the Chairman had said as to the correct way of charging costs was now actually the method used in Woolwich Arsenal, and involved no difficulties.

MAJOR WHEELER, replying on the discussion, said that it had been generally more on the accounting than on the operating side. He was glad that the Chairman agreed with his idea of having printed forms, and the value of blank spaces, ruled squares and the like. These things were essential. A blank space on a form was intended to "hit the fellow in the eye," and that was what was wanted.

The Chairman had also made a reference to his remarks on punctilious accuracy, or accuracy carried to ridiculous lengths. His illustration regarding the height of Mount Everest had an interesting little explanation given by Mr. Ackermann in his book "Popular Fallacies." Ascertainment of the height was made originally by a Frenchman, who gave it as 8,840 metres, and then someone converted this into feet, and failed to make the final digit a nought.

With regard to the kind personal remarks of Mr. Waldegrave, he would like to tell him that premature retirement did not mean leisure, but exquisite mental torture in the form of futile fretting for the past and sorry despondency for the future. Mr. Waldegrave had criticised his definition of overhead costs, but Mr. Waldegrave's

alternative definition would show how overheads behaved, and not what they were. In trying to get his own definition, he was, of course, endeavouring to get it into the smallest possible space; he could have extended it over a whole page.

Mr. Waldegrave had certainly raised an interesting point as regards running and overhead cost allocation in the case of a postman delivering a Parcel and leaving his engine running; but fortunately the all-important point was that the total cost would be included somewhere, although perhaps not strictly allocated.

In reply to Major Beaumont, he did not think that costs could be detailed too far, always, however, with the proviso that one did not overload the establishment Major Beaumont had been inclined to differ from him on standardisation in not having all one's eggs in one basket. His answer was that this was a point to be aimed at, but the difficulty in ever achieving it was its safeguard. Major Beaumont also stated that deferred overheads were not a new thing. That was quite true, but his point was that in the past this had been dodged by accountants and others, and the thing really wanted to be regularised.

The remark about costing systems being far too rigid, of which Miss Neall complained, was not his own words, but a quotation from the American pamphlet, passages of which he had read. He agreed that costing systems must be rigid in their compilation. Miss Neall had also spoken of the need for full loads. That, however, was not the engineer's job; it belonged to the managerial side. As to depreciation, a stage had now been reached when mileage and time could be blended in arriving at the estimate of this factor.

As regards Mr. Cully, he rather reminded him of the Immortal Oliver, "Please sir, I want some more." It was true that he had made some close investigation into the field of the effects of fatigue upon labour, but this and other phases, belonging more to the sphere of management than labour, must be relegated for discussion on another occasion.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Major Wheeler for his lecture, and the proceedings terminated.

CORRESPONDENCE

THE "WILLANS" ENGINE

On Page 36 in your issue of the 22nd inst., there is an allusion to the engine invented by my old school-fellow, Peter Willans, as having been first used by Colonel Crompton directly coupled to a dynamo; but the "Willans" engine had been so used already in my presence at the Thames-Ditton Works in the Spring of 1882; and the first appearance in public of such combination occurred in October, 1883, in a train-lighting experiment on the District Railway, as described in a Paper read at a meeting of the Society of Telegraph Engineers, on the 13th March, 1884.

On Pages 12 and 54 of Berly's Electrical Directory, issued in November, 1881, Messrs. John and Henry Gwynne and Mr. Hodson had illustrated advertisements of their engines coupled directly to dynamos.

W. H. MASSEY, M.Inst.C.E.

NOTES ON BOOKS

ENGLAND IN THE NINETEENTH CENTURY. 1801–1805. By A. F. Fremantle. London: Allen and Unwin, Ltd. 16s.

Mr. Fremantle's book is of absorbing interest. It is full of facts, indeed, but these facts have been selected by a historian with a sense of what is important. Certain conclusions are directly drawn for the reader, others are no less clear and suggestive because they remain implicit. The style is dry, but it flows so easily that the summons of the dinner gong is answered with reluctance; it is to be hoped that Mr. Fremantle will soon give us the second volume, which he promises conditionally on the present one receiving "a favourable verdict from the public."

The England of which he writes was parent of a generation that is more familiar to us through literature than any other in our history. In 1830, just a hundred years ago, Captain Marryatt was thirty-eight, Surtees twenty-eight, Disraeli twenty-six, Thackeray nineteen, Dickens eighteen, Trollope fifteen, and George Eliot ten. If she had lived, Jane Austen would only have been fifty-five. At any rate, the picture we have of that vital, inconsistent age is incomparable. And yet it is not altogether "a good likeness," so to speak, though Disraeli with his "Sybil" tried hard to make it fairly literal.

There developed in the early stages of the Industrial Revolution the social diversity which was perhaps the inevitable hard lot of the pioneer country. From that day to this there has been a greater emphasis on the differences between all sections of the community in England than on what they have in common. Our humanists comment with envy on the comparative geniality of life in France; three quarters of a century ago Thackeray, in his *Paris Sketches*, had anticipated all observations of the sort. Mr. Fremantle does not say too much about "British freedom," but he is bound to mention the pride which its possessors took in it—to console themselves, no doubt, for the lack of more positive blessings. Speaking of the French, Thackeray wrote: "If to our freedom we could but add a little of their happiness!"

Faith in "laws" of economics played the sinister part at the beginning of the nineteenth century which faith in "laws" of progress played at the end. Happily, the energy and determination which precipitated so much misery were only one expression of a national vitality that sought and found less grim outlets than commercial competition. Machinery had not yet squeezed the colour out of public life. Statesmen and national heroes were not yet affecting that conformity to dowdy standards of decorum which became the rule later on. Was Nelson a model of virtue—or even so much as a conventional old Sea Dog? Not he. His temperamental private life would have sat as well on a poet, and he was, of all things, a hypochondriac for "what he thought were mortal heart attacks were only spasms caused by indigestion."

Mr. Fremantle does not begin his book without introducing the subject adequately; indeed, before he sets out to describe the events of the years 1801-1805 in detail he gives us two hundred pages on the state of affairs at the close of the eighteenth century. At the end we find not only an index but a very full bibliography, and also a most useful selection of references.

In spite of all that has happened since those days, our own age and the age of Pitt, Wellington and Grey, have a certain clear affinity. Mr. Fremantle shows us a generation animated, like our own, by a sense of impending mastery, and pre-

occupied far more with means than with ends. At least hard work was apt to be recompensed better a hundred and twenty-five years ago than it is to-day : there was more elbow-room and less waste of ability. It is always possible that the general recognition of this waste will be one of the factors making for a more philosophical régime in the not too remote future.

MEETINGS OF THE SOCIETY AFTER CHRISTMAS

ORDINARY MEETINGS

Wednesday evenings, at 8 o'clock (unless otherwise announced).

JANUARY 8.—SHAW DESMOND, " The Novel—What it is and what it is not." P MORLEY HORDER, F.S.A., will preside.

JANUARY 15.—JOSEPH BURTON, A.R.C.Sc.I., of Pilkington's Tile and Pottery Company, Ltd., " Quality in Pottery." PROFESSOR H. E. ARMSTRONG, Ph.D., LL.D., D.Sc., F.R.S., will preside.

JANUARY 22.—GILBERT STONE, Barrister-at-Law, Legal Consultant to the Advisory Council on Minerals of the Imperial Institute, " Observations on the Mining Laws of the British Empire." SIR RICHARD A. S. REDMAYNE, K.C.B., M.Sc., M.Inst.C.E., will preside.

JANUARY 29.—SIR THOMAS HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Principal and Vice-Chancellor of Edinburgh University, " The International Bearing of Mineral Products." (Trueman Wood Lecture).

FEBRUARY 5.—SIR WILLIAM CLARE LEES, O.B.E. (British Economic Mission to South America), " Some Aspects of the Question of Trade with South America." SIR EDWARD T. F. CROWE, C.M.G., Comptroller General, Department of Overseas Trade, will preside.

FEBRUARY 12.—HOLBROOK JACKSON, Editorial Director of " The Drapers' Organiser," " Colour Determination in the Fashion Trades." The RIGHT HON. LORD EBURY, D.S.O., M.C., Chairman, Army and Navy Co-operative Society, will preside.

FEBRUARY 19.—" Alfred Stevens, Architect, Sculptor, Painter."

FEBRUARY 26.—PROFESSOR F. A. E. CREW, M.D., D.Sc., Ph.D., Director, Animal Breeding Research Department, University of Edinburgh, " Genetical Methods of Live Stock Improvement."

MARCH 5.—PROFESSOR ARTHUR R. LING, M.Sc., F.I.C., School of Malting and Brewing, University of Birmingham, " Brewing as a Branch of Science." SIR WILLIAM WATERS BUTLER, BT., F.C.S., Past-President of the Institute of Brewing, will preside.

MARCH 12.—PROFESSOR G. ELLIOT SMITH, M.D., F.R.S., " The Human Brain."

MARCH 19.—MRS. KATHERINE B. ESDAILE, "The Portrait in Nature, Monumental Sculpture."

MARCH 26.—HOWARD ROBERTSON, F.R.I.B.A., Principal of the Architectural Association Schools. " Architecture of To-day and To-morrow.

APRIL 2.—NATHANIEL LLOYD, O.B.E., F.S.A., " Building Craftmanship."

APRIL 30.—REV. PERCY DEARMER, D.D.

MAY 7.—S. K. RATCLIFFE, " National Parks."

MAY 14.—H. GRANVILLE-BARKER, " A National Theatre."

MAY 28.—" The Bi-centenary of Wedgwood." MAJOR FRANK WEDGWOOD will preside.

INDIAN SECTION.

Friday afternoons at 4.30 o'clock.

JANUARY 10.—SIR BASIL P. BLACKETT, K.C.B., K.C.S.I., "The Economic Progress of India." The Marquess of Reading, G.C.B., G.C.S.I., G.C.I.E. G.C.V.O., will preside.

FEBRUARY 7.—G. H. TIPPER, "Recent Mineral Development in India."

MARCH 7.—

APRIL 4.—LIEUT.-COLONEL SIR WOLSELEY HAIG, K.C.I.E., C.S.I., "The Maratha Nation." (Sir George Birdwood Memorial Lecture).

MAY 9.—DAVID CLOUSTON, C.I.E., M.A., D.Sc., "The Report of the Royal Commission on Indian Agriculture."

DOMINIONS AND COLONIES SECTION.

Tuesday afternoons at 4.30 o'clock.

JANUARY 28.—SIR DANIEL HALL, K.C.B., D.Sc., LL.D., F.R.S., "Settlers' Problems in Kenya."

FEBRUARY 25.—

MARCH 25.—O. J. R. HOWARTH, O.B.E., M.A., Secretary, British Association for the Advancement of Science, "The Work of the British Association in Relation to the Empire."

APRIL 29.—

CANTOR LECTURES.

Monday evenings at 8 o'clock.

HAROLD WRIGHT (of Messrs. P. & D. Colnaghi & Co.), "Three Master Etchers: Rembrandt, Meryon, Whistler." Three Lectures. January 20 and 27, February 3.

LECTURE I.—THE ETCHINGS OF REMBRANDT VAN RIJN, 1606-1669. Rembrandt's predecessors in etching. His earliest etchings. Etchings of beggars. The illustrations of Biblical subjects. The Landscapes. The portrait etchings. Influence of Rembrandt's work on subsequent etchers. Tributes to Rembrandt's genius as an etcher.

LECTURE II.—THE ETCHINGS OF CHARLES MERYON, 1821-1868. Meryon's parentage. His youthful voyage to the South Seas. Return to Europe. Initiation into painting and etching. Etchings after Zeeman. The Paris etchings. The Bourges and South Seas plates. The Portraits and other commissioned plates. Meryon as a Social Reformer and Poet. His death. Some tributes to his genius.

LECTURE III.—THE ETCHINGS OF JAMES MCNEILL WHISTLER, 1834-1903. His student days. Etchings of Alsace and Paris. He comes to London. The Thames series. The Portraits and Landscapes in drypoint. The Transition Period. The First Venetian series. The second Venetian series. The Cameos. The Etchings of Touraine, Paris, Brussels and the Netherlands. Whistler's influence on the revival of etching. Some tributes to his genius.

ALFRED B. SEARLE, "Recent Improvements in Methods of Brickmaking." Three Lectures. February 17 and 24, March 3.

LECTURE I.—Bricks still the most pleasing of artificial building materials; some reasons for this. Hand-moulded bricks the most beautiful but too costly

and too difficult to produce for many modern requirements. Enormous quantities now needed yearly necessitate mechanical methods of production from many kinds of materials.

Modern methods for making bricks of plastic or potentially plastic clays. Plain Bricks. Rustic Bricks.

LECTURE II.—Methods for making bricks of clay, shales, and other slightly plastic materials. The Stiff-plastic Process. The Semi-dry Process. The Tunnel Kiln and its effect on Brickworks Design. Multi-coloured Bricks.

LECTURE III.—Methods of making bricks of non-plastic materials. Sand-lime Bricks. Slag Bricks. Clinker Bricks. Bricks from Colliery Tips. Cement or Concrete Bricks. Silica Firebricks. Magnesite Bricks. Zirconia Bricks. Sillimanite and allied Bricks. Conclusion.

COMMANDER F. G. COOPER, R.D., R.N.R., "Aids to Navigation." Three Lectures. March 24 and 31, April 7.

LECTURE I.—The Mariner's Compass in various forms. The Marine Chronometer. The Pelorus and Bearing Plates. Parallel Rulers and Protractors. The Station Pointer. The Sextant and Quadrant. Dividers. The Range Finder.

LECTURE II.—Sounding Machines and Echo Sounding. W.D. Finder. Submarine Sound Signals. Whistles and Syrens. Barometers and Thermometers. The Baro-Cyclonometer (Algue's). Telescopes and Binoculars.

LECTURE III.—Clear View Screen. Patent Logs. Chernikeeff Log. Navigation in Fog. Leader Cable. Janus System of Signalling. Bell Buoys, etc. Star Charts and Globes. Tide Charts. Nautical Tables and Books. Noctovisor (Professor Baird's).

DR. MANN JUVENILE LECTURES.

CAPTAIN C. W. R. KNIGHT, M.C., F.R.P.S., F.Z.S. Two Lectures. Monday, December 30, at 3 o'clock, and Wednesday, January 1, at 3 o'clock. Illustrated by Cinematograph Films.

LECTURE I.—"The Golden Eagle."

LECTURE II.—"Wild Life in the Treetops."

(Special tickets are required for these lectures).

MEETINGS OF OTHER SOCIETIES DURING THE ENSUING WEEK.

MONDAY, DECEMBER 30. Architects, Royal Institute of British, 9 Conduit Street, W. 3.30 p.m. The Hon. Humphrey Pakington, "English Architecture. Lecture I—How it Began." (Juvenile Lecture).

TUESDAY, DECEMBER 31. Royal Institution, at the Institution of Electrical Engineers, Savoy Place, W.C. 3 p.m. Mr. S. R. K. Glanville, "How Things were done in Ancient Egypt. Lecture II—Making at Home."

Transport, Institute of, at the Institution of Electrical Engineers, Savoy Place, W.C. 5.45 p.m. Informal Meeting. Mr. [illegible] Thomas, "Papers and Discussions."

WEDNESDAY, JANUARY 1. Architects, Royal Institute of British, 9 Conduit Street, W. 3.30 p.m. The Hon. Humphrey Pakington, "English Architecture. Lecture II. How it Grew." (Juvenile Lecture).

THURSDAY, JANUARY 2. Auctioneers' and Estate Agents' [illegible] Fields, W.C. 7.30 p.m. Mr. A. Hollis, "Modern Progress—its Relation to True Value."

Royal Institution, at the Institution of Electrical Engineers, Savoy Place, W.C. 3 p.m. Mr. S. R. K. Glanville, "How Things were done in Ancient Egypt. Lecture III—Building in Stone."

FRIDAY, JANUARY 3. Architects, Royal Institute of British, 9 Conduit Street, W. 3.30 p.m. The Hon. Humphrey Pakington, "English Architecture. Lecture III—What it Means." (Juvenile Lecture).

Junior Institution of Engineers, 39 Victoria Street, S.W. 7.30 p.m. Mr. F. T. Woods, "Speedy Draughtsmanship."

Mechanical Engineers, Institution of, Storey's Gate, S.W. 6 p.m. Eng. Vice-Admiral R. W. Skelton, "Progress in Marine Engineering." (Thomas Lowe Gray Lecture).

SATURDAY, JANUARY 4. Royal Institution, at the Institution of Electrical Engineers, Savoy Place, W.C. 3 p.m. Mr. S. R. K. Glanville, "How Things were done in [illegible] Lecture IV—Boats and Furniture."